SEP 20 1928

"THE ENGINEER," SEPTEMBER 7, 1928.

OLYMPIA EXHIBITION (Sixteen-Page Supplement).

The Engineer.

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VOL. CXLVI.—No. 3791] LONDON: FRIDAY EVENING, SEPTEMBER 7, 1928 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General, India Store Department, Belvedere-road, Lambeth, S.E.1, invites TENDERS for :—
SCHEDULE 1. 16,299 STRANDED COPPER TRACK BONDS.
SCHEDULE 2. 8000 HELICAL DRAW-BAR SPRINGS.
SCHEDULE 3. One PORTABLE STEAM LOCO. CRANE, 5ft. 6in. gauge, 7 tons.
SCHEDULE 4. CRANE, STEAM TRAVELLING JIB TYPE for Timber Yard.
Tenders due on the 14th September, 1928, for No. 1; on the 18th September, 1928, for No. 2; on the 21st September, 1928, for No. 3; and on the 28th September, 1928, for No. 4.
Forms of Tender obtainable from the above at a fee (which will not be returned) of 5s. for each schedule. 9480

Air Ministry.
DIRECTORATE OF SCIENTIFIC RESEARCH.
A SCIENTIFIC OFFICER is REQUIRED for the AIR MINISTRY'S SCIENTIFIC RESEARCH STAFF, primarily for duty at the Royal Aircraft Establishment for Research Work in connection with Aircraft Power Units.
Candidates should have an Honours Degree in Engineering, in addition to having received an engineering works training; further experience in Research and Experimental Work, preferably as applied to Aircraft Engines and Accessories, is essential. Candidates should be competent to assist in the elucidation of such thermodynamic and other problems as arise in engine research. Candidates must also be medically fit for flying duties and be willing to fly as observer.
Salary £250, rising by annual increments of £20 to £350, and thence by increments of £20 to £450, plus Civil Service Bonus per annum, giving a present total starting remuneration of £353 4s. The appointment will carry superannuation under the Federated Universities' Superannuation Scheme, Government contribution being 10 per cent. of salary, individual contribution 5 per cent.
Preference given, other things being equal, to an ex-Service man.
Application should be made on a form to be obtained from the CHIEF SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants, to whom it should be returned, quoting reference No. A 297, not later than 25th September, 1928. 9461

Assistant Engineers (9) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT, for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. The foregoing officers are required to fill vacancies caused by the increase of the establishment of the Nigeria Public Works Department. Salary £480 a year for the first three years; then £510, rising by annual increments to £920. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates must have attained the age of 21½ years on the date of appointment, and should preferably have attained the age of 22½, and must not be over 35 years of age. Must have obtained an Engineering Degree at a recognised University or have passed Sections "A" and "B" of the A.M.I.C.E. examination, or have passed the Associateship in Civil Engineering of the City and Guilds Institute, or possess such other Degree or Diploma or Distinction in Engineering as may be considered satisfactory. Candidates whose qualifying diplomas have been obtained without a college course should have had three years' practical experience of Civil Engineering under a qualified Civil Engineer. It is preferred that all candidates should have had two years' practical experience on good engineering work, subsequent to taking their degree or completing their articles, but under certain conditions this may be waived in the case of candidates in possession of an Engineering Degree.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1, quoting M/254. 9455

Civil Service Commission.
The Home Office announces at least SIX VACANCIES for INSPECTORS OF FACTORIES, Class II. (Men). Salary £200, rising by £15 a year to £350, with usual Civil Service bonus in addition. The initial salary plus bonus at present rates would amount to approximately £292. The appointments carry prospect of promotion to the higher grades.
A competition for these vacancies is about to be held by the Civil Service Commissioners in consultation with the Home Office. A few additional vacancies may arise later and may be filled from among the candidates. Candidates must be over 23 and under 32 years of age on 1st October, 1928, but applications from candidates over 32 with exceptional qualifications will be considered.
The regulations for the competition and forms of application may be obtained from the INDUSTRIAL DIVISION, HOME OFFICE, London, S.W.1. The last date for submitting applications is 15th September. 9455

Draughtsman Required by the ENGINEERING DEPARTMENT of the GOLD COAST GOVERNMENT RAILWAY, for two tours of 12 to 18 months' service, with possible extension. Salary £400, rising by annual increments to £720 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged between 26 and 35, should have been articled for not less than three years to a recognised firm of Civil Engineers or Architects, and should have a thorough knowledge of drawing. Must have had some experience in the Design and Construction of Structures, Bridges, and Permanent Way. Should be neat and accurate Draughtsman, able to Calculate Stresses in simple structures of either steel, concrete or timber, and able to Take Out Quantities, Prepare Estimates, and Draft Specifications.—Apply at once by letter, stating age and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/1007. 9462

The Engineer

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The FOURTH MACHINE TOOL & ENGINEERING EXHIBITION, OLYMPIA, SEPT. 5th-22nd.
"THE ENGINEER'S" STAND will be No. 39, ROW D, at which all our Friends will be welcome.

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PUBLIC NOTICES

Engineering Assistant REQUIRED for two tours of 12 to 18 months' service by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT. Salary £600, rising by annual increments to £800 a year (commencing salary higher than £600, but not over £800 a year, may be paid to the candidate selected, should his qualifications warrant it). Free quarters and passages; outfit allowance of £60 on first appointment and liberal leave on full salary. Candidates, age 30 to 40, should be Corporate Members of the Institution of Civil Engineers. Must be able to undertake Analyses over a reasonably wide field. Must have had considerable experience in Structural Steel, Bridgework and Reinforced Concrete, both in field and drawing-office. Must be able to Take Charge of Engineering Drawing-office at headquarters, to prepare design, train junior assistant engineers and African technical staff.—Apply at once, by letter, stating age, qualifications and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/889. 9434

Northampton Polytechnic INSTITUTE, ST. JOHN-STREET, LONDON, E.C.1.
FULL-TIME COURSES are provided as follows :—
ENGINEERING.
Courses extending four years in Civil, Mechanical, Electrical, Aeronautical, and Radio Engineering and including two summer periods in the works of industrial firms.
Matriculated students are prepared for internal degree examinations of London University.
OPHTHALMIC OPTICS.
A Course extending over two years and including preparation for the Fellowship Examinations of the British Optical Association and the Spectacle Makers' Company.
Fees from £18 per annum.—For prospectus and further information apply to S. C. LAWS, M.A., M.Sc., Principal. 9406

PUBLIC NOTICES

Borough Polytechnic Institute, BOROUGH-ROAD, LONDON, S.E.1.

COMPLETE COURSES EXTENDING OVER FIVE YEARS OF EVENING WORK, LEADING TO THE ORDINARY AND HIGHER NATIONAL CERTIFICATES.

ENGINEERING SCIENCE.
PROPERTIES AND STRENGTH OF MATERIALS.
MACHINES AND HYDRAULICS.
HEAT ENGINES.
THEORY OF MACHINE AND MACHINE DESIGN.
STRUCTURAL ENGINEERING DRAWING.
STRUCTURAL STEELWORK DESIGN.
REINFORCED CONCRETE DESIGN.
HEATING AND VENTILATION.
MOTOR CAR ENGINEERING AND DESIGN.
ENGINEERS' QUANTITIES AND ESTIMATING.
PRACTICAL MATHEMATICS

ENROLMENT:
17th, 19th and 21st SEPTEMBER, 7 to 9 p.m.

Prospectus will be forwarded on application.
J. W. BISPHAM, Principal. 9394

PUBLIC NOTICES

Northampton Polytechnic INSTITUTE, ST. JOHN-STREET, LONDON, E.C.1.
EVENING CLASSES IN ENGINEERING.
All branches of Civil, Mechanical, Electrical, Aeronautical, Automobile, and Radio Engineering.
APPLIED OPTICS.
Ophthalmic Optics, Optical Instrument Making, Optical Glass Working.
HOROLOGY. FURRIERY.
APPLIED CHEMISTRY.
Fuels, Electro-plating, Metallurgy, &c.
DOMESTIC AND ALLIED SUBJECTS.
COMMENCE SEPTEMBER 24th.
Enrolments during week commencing SEPTEMBER 17th.
Free prospectuses on application to S. C. LAWS, M.A., M.Sc., Principal. 9405

Northampton Polytechnic INSTITUTE, ST. JOHN-STREET, LONDON, E.C.1.
SCHOLARSHIPS IN ENGINEERING AND OPTICS.
An EXAMINATION will be held on SEPTEMBER 19th and 20th at the Polytechnic for the Award of the following Scholarships :—
THREE SCHOLARSHIPS IN ENGINEERING, value £18 per annum.
These Scholarships are tenable at courses extending over four years in Civil, Mechanical, Electrical, Aeronautical and Radio Engineering, and including two summer periods in the works of large industrial firms.
ONE SCHOLARSHIP IN OPHTHALMIC OPTICS, value £18 per annum.
For further information apply to— S. C. LAWS, M.A., M.Sc., Principal. 9429

The Royal Technical College, GLASGOW.
DEPARTMENTS OF ENGINEERING.
MECHANICS AND MECHANICAL ENGINEERING: Professor ALEXANDER L. MELLANBY, D.Sc., M.I. Mech. E. Associate Professor WILLIAM KERR, Ph.D., A.R.T.C.
ELECTRICAL ENGINEERING: Professor STANLEY PARKER SMITH, D.Sc., M.I.E.E., A.M. Inst. C.E.
CIVIL ENGINEERING: Professor GEORGE MONCUR, B.Sc., M. Inst. C.E., M. Amer. Soc. C.E.
MINING ENGINEERING: Professor DANIEL BURNS, M. Inst. M.E.
CHEMICAL ENGINEERING: Professor of Technical Chemistry: THOMAS GRAY, D.Sc., LL.D., Ph.D., F.I.C.
Complete Courses of instruction are provided, qualifying for the Diploma and Associateship of the College and for the Degree of B.Sc. in Engineering of Glasgow University.
Composition fee 25 guineas per annum.
SESSION 1928-29 BEGINS on TUESDAY, SEPTEMBER 25th.
Calendar, by post, 9s., and prospectus, gratis, may be obtained on application to the DIRECTOR. 9007

The Sir John Cass Technical INSTITUTE, JEWRY STREET, ALDGATE, E.C.3.
Principal: GEO. PATCHIN, A.R.S.M., M. Inst. M.M.
METALLURGY for ENGINEERS; ALSO EVENING UNIVERSITY COURSES.
The following COURSES MEET the REQUIREMENTS of ENGINEERS and those wishing to prepare for the degree of B.Sc. (Eng.) in Metallurgy of London University :—
GENERAL METALLURGY.
ELECTRO-METALLURGY.
METALLURGICAL ANALYSIS AND ASSAYING.
FUEL AND REFRACTORIES.
METALLOGRAPHY, PYROMETRY AND HEAT TREATMENT.
MECHANICAL TESTING OF METALS AND ALLOYS.
ECONOMIC GEOLOGY.
NEW SESSION COMMENCES SEPTEMBER 20TH, 1928
ENROLMENT on or after September 17th, 6-8.30 p.m.
For details of the Courses apply at the Office of the Institute, or by letter to the PRINCIPAL. 9440

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PUBLIC NOTICES

UNIVERSITY OF LONDON.

King's College.

FACULTY OF ENGINEERING.

COMPLETE COURSES of STUDY are provided in CIVIL, MECHANICAL and ELECTRICAL ENGINEERING for the Engineering Degrees of the University of London and for the Diplomas and Certificate of the College.

POST-GRADUATE COURSES in CIVIL, MECHANICAL, ELECTRICAL and CHEMICAL ENGINEERING are also provided.

HEADS OF DEPARTMENTS:

Professor G. COOK, D.Sc., M.I. Mech. E., A.M. Inst. C.E., Mechanical Engineering (Dean).

S. J. DAVIES, M.Sc., M.I. Mech. E., Reader in Mechanical Engineering.

Professor A. H. JAMESON, M.Sc., M. Inst. C.E., Civil Engineering.

C. H. LOBBAN, D.Sc., A.M. Inst. C.E., Reader in Civil Engineering.

Professor E. WILSON, M. Inst. C.E., M.I.E.E., Electrical Engineering.

F. S. ROBERTSON, M.I.E.E., Senior Lecturer.

Professor S. A. F. WHITE, M.A. } Mathematics,
Professor A. E. JOLLIFFE, M.A. }

Considerable extensions have been made in the Engineering Department. These include a large additional drawing-office, lecture room and laboratory for Hydraulics and Strength of Materials in the Civil and Mechanical Departments, and research rooms, including Wireless Telegraphy, in the Electrical Engineering Department. Large additions have been made to the equipment of the Laboratories in the three Departments for purposes of teaching and research.

There is a College Hostel and a large Athletic Ground.

For full information apply to the SECRETARY, King's College, Strand, W.C. 2. 9119

Borough Polytechnic Institute,

BOROUGH-ROAD, LONDON, S.E.1.

The Governing Body REQUIRE, for the Session 1928-29, the SERVICES of EVENING LECTURERS in the following subjects:—

(a) STRUCTURAL ENGINEERING AND GRAPHICS.
(b) STRUCTURAL STEELWORK DESIGN.
(c) REINFORCED CONCRETE DESIGN.

Remuneration per evening of 2½ hours' duration will be (a) 22s., (b) and (c) 30s.

Applications, stating age, training, qualifications and experience, should be forwarded as soon as possible.

J. W. BISPHAM, Principal.

9471

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for (A) M.S. FLATS and ANGLES for 150ft. Deck Spans.

(B) M.S. RIVETS for 150ft. Deck Spans.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Thursday, 6th September, 1928.

A fee of 20s. will be charged for each copy of Specification (A), and of 10s. for each copy of Specification (B), which is NOT returnable.

Tenders must be submitted not later than NOON on Thursday, 20th September, 1928.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. C. VOLKERS, Secretary.

9460

Corporation of Rangoon.

TENDERS FOR STREET FIRE ALARMS.

The Corporation of Rangoon invites sealed TENDERS for the SUPPLY of all necessary INSTRUMENTS and APPARATUS for an INSTALLATION of STREET FIRE ALARMS on the "CLOSED CIRCUIT" PRINCIPLE, for the City of Rangoon. Specification, standard general conditions of works and Tender forms may be obtained from the undersigned at Ten Shillings per set. The Corporation does not bind itself to accept the lowest or any Tender or to assign any reason for the rejection of any Tender.

Tenders will be received by the undersigned up to Friday, the 19th October, 1928, and should be superscribed "Tender for Street Fire Alarms, Rangoon."

Ref. 2914. OGILVY, GILLANDERS & CO.,
67, Sun-court, Cornhill, London, E.C. 3.
9349 Agents for Corporation of Rangoon.

Parish of Ipswich.

HEATING AND HOT WATER SUPPLY INSTALLATION FOR THE IPSWICH POOR LAW INSTITUTION.

The Guardians of the Poor of the Parish of Ipswich invite TENDERS for the SECOND PORTION of the CENTRAL HEATING and HOT WATER SUPPLY INSTALLATION, including Steam Boiler, Calorifier, Water Softening Plant, &c., to be erected at their Institution, Heathfields, in accordance with the plans and specification prepared by the Guardians' Consulting Engineer,

George W. Martin, M.I. Mech. E.,
33, Arran-road,
Catford, London, S.E. 6.

Plans and specification can be seen either at the Guardians' Offices, or the Consulting Engineer's Office, and copies may be obtained on payment of Two Guineas, which will be returnable on receipt of a bona fide Tender which is not subsequently withdrawn.

Applications for plans and specification to be received not later than Ten o'clock on Saturday, September 15th, 1928, after which date applications cannot be considered.

The contractor will be required to pay such rates of wages as are recognised by the trades unions concerned or are generally accepted as fair in the respective trades.

The Guardians do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
L. W. GREENHALGH,
Clerk to the Guardians.

Guardians' Offices,
19, Tower-street, Ipswich.
5th September, 1928. 9468

State Electricity Commission

OF VICTORIA, AUSTRALIA,
22-32, William-street,
MELBOURNE,
AUSTRALIA.

TENDERS are HEREBY INVITED for the MANUFACTURE, TESTING, SUPPLY, DELIVERY, ERECTION COMPLETE, and MAINTENANCE of STEEL CHIMNEYS and DUST ELIMINATORS for the Yallourn Power Station, in accordance with Specification No. 28/59.

Copies of Tender form, specification, drawings, &c., will be available upon application to the Agent-General for Victoria, Victoria House, The Strand, LONDON, England.

Charge £1 1s. for three copies of Tender form, conditions of tendering, specification, contract conditions and drawings complete. This charge is returnable under certain conditions as specified in the general conditions of tendering. Extra copies, 10s. 6d. each, not returnable. A preliminary deposit of £50 shall be lodged with Tender.

Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 12th November, 1928.

The Commission does not bind itself to accept the lowest or any Tender.

W. J. PRICE,
Acting Secretary.

9423

PUBLIC NOTICES

Bethnal Green Board of Guardians,

LAUNDRY MACHINERY.

The Guardians invite TENDERS for the INSTALLATION of a VACUUM FLANNEL WASHING MACHINE at their Children's Homes in High-road, Leytonstone, E. 11.

The specification may be inspected at the undermentioned address any week-day between the hours of 10 a.m. and 12 Noon and 2 and 4 p.m., Saturdays excepted, and a copy of same with form of Tender will be supplied upon payment of a deposit of £1, which will be returned upon delivery of a bona fide Tender.

Sealed Tenders, in envelopes marked "Flannel Washing Machine," must be delivered at my Office not later than 12 Noon on Tuesday, the 25th September, 1928.

The Guardians do not bind themselves to accept the lowest or any Tender.

C. FAULKNER JONES,
Clerk to the Guardians.

Guardians' Offices,
Bishop's-road,
Bethnal Green, E. 2.
5th September, 1928. 9479

The Assam-Bengal Railway

COMPANY, LIMITED, is prepared to receive TENDERS for—

STEEL TYRES for CARRIAGES and WAGONS.
LOCOMOTIVE BOILERS.

Specifications and Tender forms may be obtained at the offices of the Company, Bishopsgate House, 80, Bishopsgate, E.C. 2. A fee of £1 1s. is charged for each specification, which cannot under any circumstances be returned.

Drawings may be had at the cost of the tenderer by application to Messrs. Hodges Bennett and Co., Ltd., 78, Queen Victoria-street, E.C. 4.

Tenders for Steel Tyres must be delivered at the Company's Offices not later than Noon on Friday, 14th September, 1928, and those for the Locomotive Boilers not later than Noon on Friday, 21st September, 1928.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
M. A. RICHARDSON,
Actg. Secretary.

30th August, 1928. 9424

Clyde Navigation Trust.

ENGINEER TO THE TRUST.

The Trustees of the Clyde Navigation invite APPLICATIONS for the POSITION of ENGINEER to the Trust.

The duties do not include the mechanical side of engineering.

Candidates must have Dock Experience, and will be expected to Design and Carry Out all Extensions and Reconstructions of the Harbour and Docks. The duties include the Control of the Dredging of the Harbour and River and the Maintenance and Renewal of all Buildings, Railway Lines and other works of the Trust. Candidates must be under 50 years of age, and should state the salary expected.

Applications, endorsed "Engineer," to be lodged with the undersigned not later than Saturday, 29th September.

JAS. MACFARLANE,
General Manager.

16, Robertson-street, Glasgow, C. 2.
5th September, 1928. 9454

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, First-class SERVICE ENGINEER for field and workshop; thorough mechanical knowledge and experience with Petrol Tractors essential; must be good organiser, also conscientious and capable worker.—Address, 9476, The Engineer Office. 9476 A

WANTED for Patent Agent's Office, TECHNICAL ASSISTANT for Chemical Work; knowledge of German advantageous. State age, salary and experience.—Address, 9448, The Engineer Office. 9448 A

WANTED IMMEDIATELY, YOUNG ENGINEER, age 21-25, who can prove ability and willingness to take extreme care with every detail of his work. Thorough training in workshops, drawing-office and tool-room essential. Ability to make new designs, erect small plant and organise production on time-saving basis also necessary. Good remuneration and encouragement to young man with initiative and the capacity for taking great pains with everything he does.—Address fully, stating salary required, 9438, The Engineer Office. 9438 A

C.A. WANTED for Large Shipbuilding and Engineering Company in the Far East. Age 28-30. Must have good knowledge of Engineering matters. Good salary and prospects to suitable man.—Apply by letter to "C.A.," c/o Abbotts, Ltd., 32, Eastcheap, London, E.C. 3. P4889 A

ENGINEER (MECHANICAL), Well Trained, with Sales and General Commercial Experience, age about 30, REQUIRED for Sales Department of Malayan Rubber Manufacturers. Healthy climate. Free single quarters. Sales Manager, now in London, will interview suitable candidates.—Write, with full details, to Box 505, c.o. Judd's, 47, Gresham-street, London, E.C. 2. 9481 A

ENGINEER REQUIRED by Firm of Coal-preparation Plant Manufacturers on North-East Coast. Applicants must be able to deal with Foreign Correspondence and speak French and German fluently.—Address, stating age, experience and salary required, 9474, The Engineer Office. 9474 A

ENGINEER, with Knowledge of Design of Rubber Plantation M/c and Hydraulic Presses, &c., REQD. in London.—Address, giving age and exp., with sal. reqd., 9470, The Engineer Office. 9470 A

EXPERIENCED ENGINEERS' STOREKEEPER WANTED, to Take Charge of Large Stores, S.W.1. Give full particulars, experience and salary required.—Address, 9444, The Engineer Office. 9444 A

REINFORCED CONCRETE DESIGNER. — A VACANCY OCCURS for an ENGINEER having specialist experience in Reinforced Concrete Design. Applications should give in confidence a brief summary of experience, age and salary required.—Address, 9437, The Engineer Office. 9437 A

REPRESENTATIVE WANTED for London, with good connection for Repairs and General Engineering Work.—Write only, stating age and experience, to BARRON'S, Ltd., 120, High-street, Tooting, S.W. 17. P4911 A

REQUIRED, a CLERK OF WORKS, Capable of hurrying forward material and carrying out all duties in connection with the erection of new works. State experience and salary required.—Address, 9472, The Engineer Office. 9472 A

REQUIRED in a Large Motor Car Works, a First-class CHIEF JIG and TOOL DESIGNER. Applicants must be accustomed to production of high-class work at low cost and to be able to settle methods of operation, fix production times and to superintend design of tools. Only really first-class men need apply. Others will be wasting their time. Give particulars of experience, age, &c., and salary required.—Address, 9407, The Engineer Office. 9407 A

TRAVELLING REPRESENTATIVE WANTED, age 30/40, for an old-established Crane Firm; only those who are technically trained and have had previous experience need apply.—Applications should state fullest particulars, age and salary required, and be addressed to the MANAGER, Thomas Smith and Sons (Rodley), Ltd., Rodley, Leeds. 9464 A

WANTED for London, JUNIOR DRAUGHTSMAN. —Apply by letter only, stating age, experience, and salary required, GWYNNES PUMPS, Hammersmith, W. 6. 9453 A

SITUATIONS OPEN (continued)

WANTED, ASSISTANT DRAUGHTSMAN for Structural Steelworks in Southern Counties; must be of good address, capable of Taking Charge in absence of Head Draughtsman. Quick at work and good detailer. Able to get out designs and estimates for Steel Buildings. State age, experience and salary expected.—Address, P4907, The Engineer Office. P4907 A

WANTED, Experienced RAILWAY CARRIAGE and WAGON DRAUGHTSMEN.—Apply by letter, giving particulars of experience and salary required, the BIRMINGHAM RAILWAY CARRIAGE and WAGON CO., Ltd., Smethwick. 9401 A

WANTED IMMEDIATELY, HEAD DRAUGHTSMAN for Structural Steelworks in South of England; must have good presence and courteous manner, accustomed to interview architects and engineers, and capable of getting out designs and estimates for Steel Buildings. State age and experience.—Address, P4906, The Engineer Office. P4906 A

WANTED, the SERVICES of a First-class SENIOR DRAUGHTSMAN for a large concern in the Eastern Counties, to Take Charge of Drawing-office section and be of personal assistance to the chief engineer. Must have sound Mechanical Engineering knowledge, including Hydraulics, Grinding, Sifting and Mixing Machinery. Applicants must be energetic and competent to act without supervision and be 30/35 years of age.—Address, with full particulars of experience, stating age and salary required, 9467, The Engineer Office. 9467 A

CHIEF DRAUGHTSMAN and PROGRESS ENGINEER, about 35, REQUIRED, to take charge and speed up Water Softening Plant Contract Dept. Erection and works experience essential.—Write fully, stating experience and salary required, to Box 696, Sells, Fleet-street, E.C. 4. 9481 A

CHIEF DRAUGHTSMAN REQUIRED for Electric Vehicles. Application will be treated in strict confidence. — ELECTRICARS, Ltd., Lawley-street, Birmingham. P4929 A

CRANE DRAUGHTSMAN.—APPLICATIONS INVITED from experienced and capable DRAUGHTSMEN, accustomed to all types of Steam and Electric Cranes; must be able to work on own responsibility. Applications, which will be treated in confidence, must give full particulars of training and experience, age, reference and salary required.—Address, P4931, The Engineer Office. P4931 A

DRAUGHTSMAN (Good, Senior) WANTED for Locomotive Works in Yorkshire.—Address, 9465, The Engineer Office. 9465 A

DRAUGHTSMAN REQUIRED IMMEDIATELY, with first-class experience in the Design of Industrial Furnaces.—Reply fully to STEIN and ATKINSON, Ltd., 47, Victoria-street, London, S.W. 1. 9478 A

DRAUGHTSMAN REQUIRED. Preference given to one with experience on Torpedo Details.—Write, stating age, experience, and salary required, to the WHITEHEAD TORPEDO CO., Ltd., Weymouth. 9436 A

DRAUGHTSMAN REQUIRED with Considerable experience in Dust Removal and Ventilating Plants; must be used to measuring and preparing working details.—Write fully, P4936, The Engineer Office P4936 A

DRAUGHTSMAN REQUIRED, with Experience in Reinforced Concrete Design and knowledge of General Building Construction. State experience, age, salary and when free.—Address, P4928, The Engineer Office. P4928 A

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For continuation of Small Advertisements see page 4.

A Seven-Day Journal

New British Submarines.

ON Friday last, August 31st, there was launched from the Naval Construction Works of Vickers-Armstrongs, Ltd., at Barrow-in-Furness, H.M. submarine "Otus," the third of the three "O" class submarines which were ordered from Vickers Ltd. under the 1926 naval programme. The naming ceremony was performed by Mrs. Grace, the wife of Rear-Admiral H. E. Grace, Admiral of Submarines. The sister ships, the "Osiris" and the "Oswald," were successfully put afloat on May 19th and June 19th respectively. Another submarine of the "O" class is being built at the Chatham Dockyard, while two others are under construction at the Dalmuir yard of William Beardmore and Co., Ltd. In addition to the three submarines we have referred to, which are now being completed at Barrow, Vickers-Armstrongs, Ltd., have also orders for four "P" class submarines for the British Admiralty, which were authorised under the 1927 naval programme. At the Barrow yard there are, also, three submarines under construction for the Chilean Government. They are of the "O" class design, by permission of the British Admiralty. At the recent launch of the submarine depôt ship "Medway," Admiral Chatfield made reference to the new Admiralty policy of allowing our war experience to be used by other friendly nations, which is exemplified in the case of these Chilean submarines.

A Single Wavelength for Wireless Relay Stations.

THE British Broadcasting Corporation announces that during November and December ten relay stations will take over the national exclusive frequency of 1040 kilocycles, corresponding to 288·5 m., thereby replacing the international common frequencies which they have been sharing with stations abroad. The process will be a gradual one, each station changing its frequency as soon as the necessary additional plant has been installed. Heterodyne interference has become so serious on the international common frequencies that the service areas of relay stations have been reduced to from one-half to two miles radius during the hours of darkness, thus seriously discounting their value under existing conditions. It has been decided, pending the introduction of the regional scheme, to work the relay stations on a single wave length, in the hope of reviving their usefulness. It is anticipated that this will considerably improve reception, particularly in the thickly populated areas of Liverpool, Stoke-on-Trent, Bradford, Hull, Sheffield, Swansea, Plymouth, and Dundee. As the Leeds station is in close proximity to Bradford, and is already working under conditions moderately free from interference, it will continue to work at its present frequency of 1080 kilocycles, corresponding to 277·8 m. The exclusive frequency of Bournemouth, namely, 920 kilocycles—326·1 m.—will be transferred to Aberdeen, which will then be able to serve a much wider area than would be possible if that station worked on a common national or international frequency. The transmitter at Bournemouth will continue its service on the national frequency of 1040 kilocycles, as it is anticipated that this arrangement will provide adequate service for Bournemouth itself, while the surrounding district will normally be served by Daventry.

Pulverised Fuel on a Cargo Liner.

REFERENCE was made in last week's Journal to the pulverised fuel equipment of the Woodeson type, installed by Clarke, Chapman and Co., Ltd., of Gateshead, on the Blue Star cargo liner "Stuartstar." On Friday last, August 31st, by invitation of the owners, we were able to inspect this installation on the arrival of the ship from South America. The boilers of the "Stuartstar" comprise two single-ended and two double-ended Scotch boilers of the four-furnace type. They are designed for a working pressure of 200 lb. per square inch, and no superheaters are fitted. The voyage occupied about seven weeks, and the fuel employed for pulverisation was a Northumberland small coal of 12,900 B.Th.U. per pound heating value, with 13 per cent. ash and about 2 per cent. of moisture. The cost of this fuel was about 6s. per ton, less than that of the coal ordinarily used in hand-fired boilers. On an average over the voyage about 14 tons of pulverised fuel were burned per day, or nearly 2 tons less than in a similar boiler when hand-fired with lump coal. We were informed that the power required for pulverising and distributing the fuel was no more than 1 horse-power per ton of coal. The boiler efficiency on pulverised fuel was 80 per cent., or about 15 per cent. higher than when hand fired. Analysis of the flue gases showed that the CO_2 content was 15 to 17 per cent. with 0·50 of CO, compared with a CO_2 content of 3·0 to 8·5 per cent. under hand-fired conditions. The heating surface of the boiler is 3926 square feet, and the combustion space for each furnace has a capacity of 61·4 square feet. The average furnace temperatures on the outward and inward voyage varied between 2400 and 2542 deg. Fah. The smoke-box temperature was 610 deg. Fah., and the draught was about ½in. water gauge measured above the air heaters. As already stated in these columns, the "Stuartstar" will go to sea on her next voyage with twelve of her twenty-four furnaces arranged for pulverised fuel burning, and the owners propose to equip one of their passenger liners for pulverised fuel, probably the "Andalucia," at an early date.

The Machine Tool Exhibition.

AT the inaugural luncheon of the Machine Tool and Engineering Exhibition at Olympia on Wednesday last, when Mr. Bridgeman declared the Exhibition open, Sir Alfred Herbert, President of the Machine Tool Trades' Association, said that it was the largest which had ever been held in this country, and was 50 per cent. larger than that of four years ago. He was glad to welcome a number of American engineers, as he felt that British engineers might possibly learn something from them. In that connection he pointed out that this country and the United States had each developed its own style of production to suit national needs. Mr. Bridgeman said that if only he were provided with more funds he would leave the Exhibition with a number of machines which would enable him to effect economies in the dockyards; but, fortunately, the Admiralty possessed a number of engineers who were capable of keeping their old machines running. Nevertheless, those machines must ultimately wear out, and then would be replaced by modern machinery. He remarked on the great amount of labour entailed by the organisation of such an exhibition, and wondered what would be the ultimate effect on the mentality of the nation by the employment of such a mass of foolproof machinery. Mr. W. B. Lang, vice-president of the Association, in proposing a vote of thanks to Mr. Bridgeman for opening the Exhibition, said that they on the Clyde had probably one of the most difficult furrows to plough, but thought that there were signs of a steady, if slow, improvement in industry.

Electric Trains at Manchester.

THE railway line between the London-road Station, Manchester, and Altrincham is to be electrified, and it is said that the work will be started this month. The line is to be operated on the overhead system, at a pressure of 1500 volts. It is proposed to provide two new passenger stations on the line, one at Ashton-on-Mersey, and the other at Navigation Crossing. The present Old Trafford Station on the line, which is now only used for special traffic in connection with cricket and football matches, will be made a regular stopping-place for the service of that portion of South Manchester. The scheme will necessitate the enlargement of the carriage sheds at Altrincham, and the construction of many additional coaches, as well as the construction of electric locomotives. The scheme will result in a much better service of trains between Manchester and stations up to and including Altrincham. It is a joint undertaking of the Cheshire Lines Committee and the former Great Central and London and North-Western Railways, and if the financial and business prospects of the railways had been normal, instead of unusually depressed, it is possible that the undertaking would have been on a considerably larger scale. It is, in fact, expected that this branch line will be extended into a loop which will include portions of two other South Manchester lines—the direct line between Manchester and Wilmslow as far as East Didsbury, and the portion of the Stockport and Altrincham line of the Cheshire Lines Committee, eastward of Cheadle Station. These extensions would give electric service to Longsight, Burnage, Mauldeth-road, East Didsbury, Cheadle, Gatley, Northenden, and Baguley—all residential districts that have been extended since the war, and forming collectively the only area where suburban expansion of Manchester now remains possible.

The British Association.

THE ninety-eighth meeting of the British Association for the Advancement of Science was opened in Glasgow on Wednesday, September 5th, and will continue until Wednesday, September 12th. The President of the Association this year is Professor Sir William H. Bragg, K.B.E., F.R.S., who was duly inducted into the chair at the inaugural meeting on September 5th by Sir Arthur Keith, F.R.S., the retiring President. The City and University of Glasgow offered this year, for the fifth time, a cordial welcome to the B.A. In 1840, when the Association met for the first time in Glasgow, it was under the presidency of the Marquis of Breadalbane, F.R.S. When the second visit took place in 1855, the President was the Duke of Argyll, F.R.S., in 1876 the President was Professor Thomas Andrews, F.R.S., and in 1901 Sir Arthur Rucker, F.R.S., presided. The intervening period of twenty-seven years has seen some remarkable changes in Glasgow in every direction, not the least of which relate to engineering, shipbuilding, and education, and opportunities will be afforded during the week of the meeting of seeing something of these changes. A not uninteresting feature this year is that all the sectional meetings will be held in the University buildings, an arrangement which will be greatly to the comfort of those whose interests cover more than one section. It is seldom that a B.A. meeting passes without some complaint of the difficulty of getting around from section to section, although the trouble is usually inevitable owing to the nature of the available accommodation. This year, however, the sectional meetings are being held under conditions of comfort and convenience unsurpassed in any other town. The inaugural meeting took place at 8.30 p.m. on Wednesday evening, when Sir William Bragg delivered an address entitled "Craftsmanship and Science," of which we give an abridged report elsewhere in this issue.

Tilbury Dock Improvements.

WHEN describing in the issue of THE ENGINEER of July 13th last the improvements at the Tilbury, West India and Millwall Docks, we referred to the reversible floating caisson for the Tilbury Dock. This caisson has been built to the order of Sir Robert McAlpine and Sons, London, Ltd., at the Wallsend Shipyard of Swan, Hunter and Wigham Richardson, Ltd., and it was safely launched on Tuesday last, September 4th. It has a length of 114ft., with a breadth of 25ft. 6in., and a depth overall of 44ft. 1in. The caisson is divided by two watertight decks and two watertight bulkheads into five chambers, the bottom and top of the air chambers being formed by the watertight decks. It is constructed in mild steel with greenheart timber facings, where joints with the masonry are to be made. With all gear on board and empty tanks, it is designed to float at a draught of 26ft. 10in. An electrically-driven pump and two hand pumps are fitted. Work is proceeding very satisfactorily on the completion of the new P. and O. berths in the southern branch of Tilbury Dock, and it is anticipated that the company will be able to change over to its new berthing quay during the coming autumn season. The new quay has a length of 2200ft., immediately adjacent to and in direct line with the new dock, and special landing and railway facilities are provided.

The Shipbuilding Position.

THE shipbuilding output on the Clyde for the month of August included twenty-two vessels, totalling 73,535 tons. This output was the largest of the present year, and the first eight months of the year show an output double that of the same period last year. Some new work is expected from the orders for ten cargo ships received by Swan, Hunter and Wigham Richardson, Ltd., from Canadian owners, as this contract will be divided between Clyde and North-East Coast yards. Elder, Dempster and Co., Ltd., of Liverpool, have placed orders for four 4000-ton motor ships on the Clyde, two of which will be built by Archibald McMillan and Son, Ltd., of Dumbarton, one by David and William Henderson and Co., Ltd., at Partick, and one by the Ardrossan Dockyard Company, Ltd. of Ardrossan. At Belfast the three yards of Harland and Wolff, Ltd., are well employed, and over a quarter of a million tons of shipping is under construction. A new motor vessel for the Pacific Steam Navigation Company, Ltd., is to be laid down on one of the few vacant berths. Workman, Clark and Co. (1928), Ltd., are becoming better employed, and since the recently ordered Ellerman liner, the firm has been successful in securing a new order for a 600ft. 18,000-ton oil tanker. Some new orders placed on the North-East Coast include two large cargo steamers, which are to be built at the yard of William Gray and Co., Ltd., West Hartlepool, to the order of Sir Robert Ropner and Co., Ltd. Altogether the outlook is more promising than it has been for some time past, but further orders are needed if the larger yards are to be kept well employed. The well-known Paisley firm of John Fullerton and Co. announces its intention of retiring from the business of shipbuilding, which it began in 1867.

The Piccadilly Underground Station.

AN inspection of the progress made to date at the new station for the Underground Railways at Piccadilly Circus indicates that in all probability the work, which was begun in February, 1925, will be completed about the end of the year, when it is hoped that the new station will be opened for traffic. It has been designed to deal with 50,000 passengers per hour, a capacity which is over double that of the old station. The circular booking hall, which is 15ft. below the surface of the roadway, will be reached by seven short subways, giving access from the different streets. It will have an area of 25,000 square feet, and will accommodate thirty automatic booking machines and four passimeter booths. In all, there are eleven escalators at the new station; five of these, of which three are accommodated in one tunnel and two in another, will connect the booking hall with a common landing, 57ft. below. Arrangements are made whereby these escalators may be operated either upwards or downwards to meet traffic requirements. Their combined capacity is 40,000 passengers per hour. From the common landing two tunnels, each with three escalators, make connection with the Bakerloo and Piccadilly Railway platforms, which are respectively 82ft. and 106ft. below the street level. The whole cost of the new station is estimated at half a million pounds. In our issue of July 13th we published an article on the progress of the work after a personal inspection, and in our issues of April 29th and May 6th, 1927, a fully illustrated description of the scheme was given.

The Flexibility of Plain Pipes.

By J. R. FINNIECOME, M. Eng. (Zurich), M. Soc. Ing. C. (France).

No. IV. (*conclusion*).*

Deflection-Stress Correction Factor.

Space does not permit the author to go fully into the derivation of formulæ for the various stresses based on the Karman theory. He will, however, present these formulæ in such a way that by applying correction factors to the formulæ of the simple bending theory, the stresses can be calculated very quickly.

(1) *The Karman Deflection Based on the Theoretical Longitudinal Stress.*—

$$\Delta_K = K_S \left(\frac{f_b}{E}\right) \frac{2}{d_1} \frac{\int y^2\, ds}{y_{max}} \quad . \; . \quad (26)$$

where K_S is the Karman deflection-stress correction factor. This factor is expressed by formulæ (46) and (52) in Table XVIII, and its values for various pipe factors are given in Table XV., Col. 3.

Table XV.—*Karman Correction Factors for Various Pipe Factors.*

1	2	3	4	5
φ	K_H	K_S	K_T	$\frac{1}{K_T}$
0·3	5·325	2·703	0·5076	1·970
0·4	4·082	2·602	0·6375	1·569
0·5	3·250	2·497	0·7681	1·302
0·6	2·691	2·379	0·8840	1·131
0·7	2·308	2·258	0·9786	1·022
0·8	2·037	2·141	1·0520	0·9517
0·9	1·839	2·026	1·1020	0·9075
1·0	1·692	1·919	1·1340	0·8819
1·1	1·579	1·817	1·1500	0·8691
1·2	1·491	1·724	1·1560	0·8651
1·3	1·423	1·640	1·1520	0·8680
1·4	1·367	1·553	1·136	0·8806
1·5	1·321	1·483	1·123	0·8910
1·6	1·283	1·418	1·105	0·905
1·7	1·252	1·367	1·092	0·9159
1·8	1·219	1·325	1·087	0·9196
1·9	1·203	1·290	1·072	0·9325
2·0	1·183	1·261	1·065	0·9382

(2) *Karman Longitudinal Stress.*—(*a*) Maximum—

$$f_{bK} = \frac{1}{K_T} \frac{H}{2} \left(\frac{d_1}{I}\right) y_{max} \quad . \; . \; . \quad (28)$$

where $\frac{1}{K_T}$ is the Karman thrust-stress correction factor. This factor can be calculated from formulæ (48) and (54) in Table XVIII. and its values for various pipe factors are given in Table XV., Col. 5.

(*b*) *At a Distance z from Neutral Axis.*—

$$f_{bK} = [K_H\, k_{r_1}\, \psi_z] \frac{H}{2} \left(\frac{d_1}{I}\right) y_{max} \quad . \; . \quad (35)$$

The values for K_H—see formulæ (19)—for various pipe factors can be obtained from Table XV., Col. 2, and for ψ_z for various z-radius factors from Fig. 22.

Comparison of the Actual Longitudinal Stress Obtained from Tests with the Karman Longitudinal Stress.

We shall now consider to what extent the test figures of (*a*) actual maximum longitudinal stress, (*b*) the longitudinal stress at any distance from the neutral axis agree with the Karman stress theory.

Actual Maximum Longitudinal Stress.—When examining the Bantlin test some ten years ago, the author came to the conclusion that the maximum longitudinal stress agreed very closely with the Karman theory. A comparison of the ratio of the test to the theoretical deflection-stress factor with the Karman deflection-stress correction factor (K_S) is given in Table XVI. for the Bantlin pipe, 200 mm. We find for this particular pipe that the test ratio (C_S) is 0·885 times the Karman deflection-stress correction factor (K_S).

Professor Hovgaard is to the writer's knowledge the only experimenter who has published data of the actual longitudinal stresses in a pipe as obtained from the measurement of the actual strain. In Table XVI., Col. 4, a comparison is given of the maximum stress calculated by the simple bending theory—Item 7—with that actually obtained by test for the Walworth pipe. We find that the test ratio of the actual to the theoretical deflection-stress factor is 0·852 times the Karman deflection-stress correction factor K_S.

Distribution of Longitudinal Stress at any Distance from the Neutral Axis.—It is only since the publication of Professor Hovgaard's particularly interesting stress curve obtained from actual test data that we have received the assurance that the longitudinal stress at any distance from the neutral axis corresponds very closely with that of the Karman theory. As this stress curve is of great interest, it is reproduced in Fig. 23, where also are shown for the sake of comparison the stresses for the simple and the Karman bending theory. From the observed strain, the stress was calculated by multiplying the strain by the modulus of elasticity in accordance with Hooke's Law. From Fig. 23 it will be seen that the shape of the actual test stress curve resembles very closely the Karman stress curve, and that the maximum longitudinal stress occurs, not at the top of the cross section, as in the simple bending theory, but at the same distance from the neutral axis, as calculated by Karman.

Table XVII.—*Comparison of the Maximum Theoretical Longitudinal Bending Stress with the Karman Transverse and Combined Stresses on the Outside Diameter for the Walworth Pipe* ($\varphi = 0{\cdot}785$).

1	2	3	4	5	6
Item	Symbol.	No. of Form.	No. of Fig.		Walworth lyre bend.
1	d			Inside diameter, inches	6·127
2	d_1			Outside diameter, inches	6·656
3	I			Moment of inertia, in⁴.	27·12
4	y_{max}			y_{max} for the cross section, where transverse strain measurements were taken by Professor Hovgaard, inches	93·39
5	φ			Pipe factor for this cross section	0·785
6	H			Thrust, lb.	1,200
7	$\frac{[\psi_r]}{[K_T]_{to}}$	66	24 and 24a	Ratio of the maximum Karman transverse bending stress to the maximum theoretical longitudinal bending stress (at A, Fig. 28)	2·1
8	$\frac{1}{[K_T]_{to}}$	57	24	Ratio of the Karman transverse bending stress at the neutral axis to the maximum theoretical longitudinal bending stress	1·797
9	$\frac{1}{[K_T]_{o1}}$	90		Ratio of the maximum Karman combined bending stress to the maximum theoretical longitudinal bending stress	2·622
10				Ratio of the Karman combined stress at F (Fig. 28) to the maximum theoretical longitudinal bending stress	2·040
11	$\frac{f_{c_1}}{[f_{bK}]_{to}}$	76		Ratio of the maximum Karman transverse compressive stress to the Karman transverse bending stress (both at the neutral axis)	0·063
12	f_b	5		Maximum theoretical longitudinal bending stress, lb. per square inch	13,810
13	f_{bK}	28		Maximum Karman longitudinal bending stress, lb. per square inch	12,730
14	$[f_{bK}]_1$	60		Maximum Karman transverse bending stress, lb. per square inch	29,000
15	f_{c_1}	74		Maximum Karman transverse compressive stress (neutral axis), lb. per sq. in.	1,560
16	$[f_{bK}]_{o1}$	86		Maximum Karman combined bending stress (at A, Fig. 28), lb. per square inch	36,210
17	$[f_{bK}]_{to}$	58		Karman transverse bending stress at neutral axis, lb. per square inch	24,810
18	$[f_{bK}]_F$			Karman combined bending stress at F (Fig. 28), lb. per square inch	28,170
19	$[f_{ko}]_{to}$	77		Transverse stress at neutral axis, lb. per square inch	23,250
20	$[f_{ko}]_{to}$ (test)			Maximum transverse stress obtained from strain measurements at neutral axis by Professor Hovgaard, lb. per square inch	30,280
21	(20) / (19)			Ratio of test to Karman transverse stress	1·301

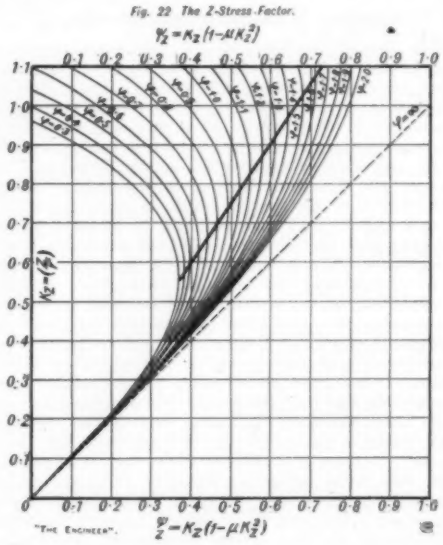


Fig. 22 The Z-Stress-Factor.
$\frac{\psi_z}{z} = K_Z(1-\mu K_Z^2)$
0·1 0·2 0·3 0·4 0·5 0·6 0·7 0·8 0·9 1·0
1·1 1·0 0·9 0·8 0·7 0·6 0·5 0·4 0·3 0·2 0·1 0
$K_Z = (\frac{y}{z})$
$y_z = \infty$
"The Engineer".

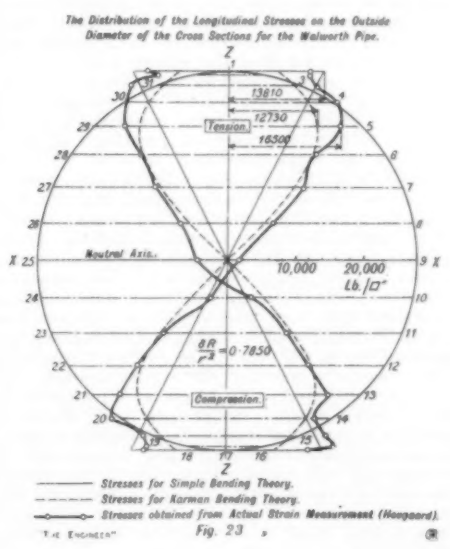
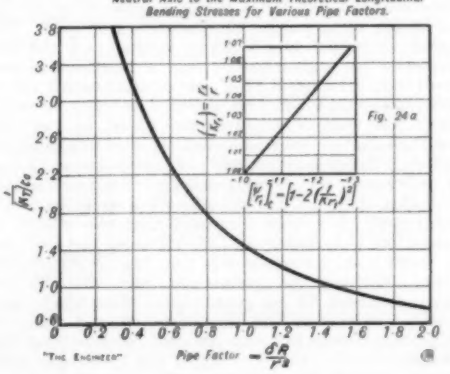


Table XVI.—*Comparison of the Ratio of the Test to the Theoretical Deflection-Stress Factor* (C_S) *with the Karman Deflection-Stress Correction Factor* (K_S).

1	2	3	4
Item.		Bantlin 200 mm. bend.	Hovgaard's Walworth bend.
1	Inside diameter, inches	7·95	6·127
2	Outside diameter, inches	8·474	6·686
3	Moment of inertia, in⁴.	56·98	27·12
4	Y max., inches	88·6	93·39
5	Pipe factor corresponding to K_H (Table XIV., Col. 16/1 and 2)	0·4931	0·7831
6	Thrust, lb.	3,041·5	1,200
7	Theoretical maximum bending stress due to thrust, lb. per sq. in.	20,185	13,810
8	Actual maximum bending stress due to thrust (test), lb. per sq. in.	41,160	16,500
9	Test ratio (C_H) = $\frac{C_H\text{ (test)}}{C_H\text{ (theor.)}}$ (Table XIV., Col. 17/1 and 3)	4·507	2·196
10	Test ratio (C_T) = $\frac{C_T\text{ (test)}}{C_T\text{ (theor.)}}$ $\frac{\text{Item (7)}}{\text{Item (8)}}$	0·4898	0·837
11	Test ratio (C_S) = $\frac{C_S\text{ (test)}}{C_S\text{ (theor.)}}$ (Item 9 × Item 10)	2·208	1·838
12	Karman deflection-thrust correction factor (K_H) (Table XIV., Col. 16)	3·298	2·076
14	Karman thrust-stress correction factor (K_T) $\left(\frac{\text{Item 13}}{\text{Item 12}}\right)$	0·756	1·040
13	Karman deflection-stress correction factor (K_S)	2·495	2·158
15	$\frac{K_S}{\text{Test ratio } (C_S)}$ $\left(\frac{\text{Item 13}}{\text{Item 11}}\right)$	1·13	1·175
16	$\frac{\text{Test ratio } (C_S)}{K_S}$ $\left(\frac{\text{Item 11}}{\text{Item 13}}\right)$	0·885	0·852

Fig. 24 *Ratio of the Karman Transverse Bending Stress at the Neutral Axis to the Maximum Theoretical Longitudinal Bending Stresses for Various Pipe Factors.*



Karman Transverse Stresses.

So far, we have considered only the longitudinal bending stress in the cross section of the pipe. According to the Karman theory, the force which causes the flattening of the circular cross section produces transverse stresses for a section which is normal to the circular cross section. The transverse stress consists

* No. III. appeared August 31st.

of (*a*) transverse bending stress, (*b*) transverse compression or tensile stress, (*c*) total transverse stress. The author has derived the following series of formulæ with curves and tables for assisting the designer in the calculation of these stresses :—

(*a*) *Transverse Bending Stress.*—(1) *At a Distance z from Neutral Axis.*

$$[f_{bK}]_z = \frac{[\psi_z]_t}{[K_T]_0} \frac{H}{2} \left(\frac{d_1}{I}\right) y_{max} \quad . \quad . \quad (62)$$

The value for $\frac{1}{[K_T]_t}$ can be calculated by formula (57), Table XVIII. and $[\psi_z]_t$ for various z-radius factors is given in Fig. 25.

(2) *At Neutral Axis.*

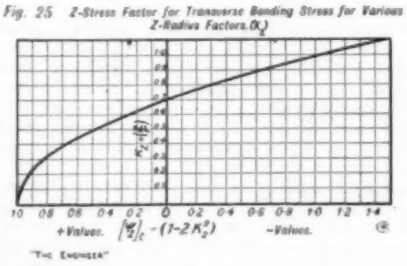
$$[f_{bK}]_0 = \frac{1}{[K_T]_0} \frac{H}{2} \left(\frac{d_1}{I}\right) y_{max} \quad . \quad . \quad (58)$$

(3) *Maximum at Top of the Outside Diameter of the Cross Section.*

$$[f_{bK}]_1 = \frac{[\psi r_1]_t}{[K_T]_0} \frac{H}{2} \left(\frac{d_1}{I}\right) y_{max} \quad . \quad . \quad (65)$$

By multiplying the factors $\frac{1}{[K_T]_0}$ and $[\psi r_1]_t$, as obtained from Figs. 24 and 24*a* respectively by the theoretical longitudinal bending stress, we are able to determine the maximum Karman transverse bending stress. We find that the maximum Karman transverse bending stress at the top of the outside diameter of the cross section of the pipe is greater than the Karman transverse bending stress at the neutral axis by a percentage equal to four times the percentage increase of the outside to the mean radius of the cross section.

Fig. 25. Z-Stress Factor for Transverse Bending Stress for Various Z-Radius Factors. $(\frac{z}{r})$



The ratio of the Karman transverse bending stress at the neutral axis to the maximum Karman longitudinal bending stress for various pipe factors is plotted in Fig. 26. The ratio of the maximum transverse bending stress to the maximum Karman longitudinal bending stress is given by :—

$$\frac{[f_{bK}]_0}{f_{bK}} = \frac{K_T}{[K_T]_0} [\psi r_1]_t \quad . \quad . \quad . \quad (71)$$

By using the factors in Figs. 24 and 26, we are able to calculate this ratio very easily.

The ratio of the maximum transverse bending stress to the Karman transverse bending stress at the neutral axis is equal to $[\psi r_1]_t$ plotted in Fig. 24*a*.

Karman Transverse Compressive and Tensile Stress.—This stress, which is compressive on the outside and tensile on the inside, is produced by the tangential component of the force which causes the flattening of the circular cross section.

The maximum compressive stress will occur for a transverse section through the neutral axis. We find that

$$f_{C_0} = \left[k_{r_1}{}^2 \left(\frac{d_1}{R}\right) \frac{6\varphi^2 + 1}{12\varphi^2 + 1}\right] f_b \quad . \quad . \quad (74)$$

Total Transverse Stress at the Neutral Axis.—(1) For the outside surface of the pipe—

$$[f_{KO}]_0 = [f_{bK}]_0 - f_{C_0} \quad . \quad . \quad (77)$$

(2) For the inside surface of the pipe—

$$[f_{KI}]_0 = [f_{bK}]_0 + f_{C_0} \quad . \quad . \quad . \quad (78)$$

KARMAN COMBINED STRESS.

For the calculation of the combined stress the author has applied Guest's Theory, which has been confirmed by Guest's tests in 1900 for ductile materials. Guest's Law is generally used in this country, and is known as the maximum stress difference theory. According to it, the maximum principal stress difference is equal to twice the maximum shear stress. We get the maximum principal shear stress

$$\tau_z = \tfrac{1}{2}(f_{bK} - [f_{bK}]_{tz}) \quad . \quad . \quad . \quad (79)$$

and thus the combined stress

$$[f_{bK}]_0 = f_{bK} - [f_{bK}]_{tz} \quad . \quad . \quad . \quad (80)$$

General Formula for the Combined Karman Stress at Distance z from the Neutral Axis.

$$[f_{bK}]_{0z} = \left\{K_H k_{r_1} \left(\frac{z}{r}\right)\left[1 - \mu\left(\frac{z}{r}\right)^2\right] - \frac{1}{[K_T]_0}\left[1 - 2\left(\frac{z}{r}\right)^2\right]\right\} f_b \quad . \quad (82)$$

Maximum Combined Bending Stress.—This stress occurs at the top of the outside diameter of the cross section for $\varphi > 0{\cdot}35$, and can be obtained from the following formula :—

$$[f_{bK}]_{01} = \frac{1}{[K_T]_0} f_b \quad . \quad . \quad . \quad (91)$$

The values for $\frac{1}{[K_T]_0}$ (see formula (94), Table XVIII.) for various pipe factors are plotted in Fig. 27. We find that the maximum combined stress is 3·07, 2·212, 1·680 times greater than the maximum theoretical longitudinal bending stress for $\varphi = 0{\cdot}4$, $1{\cdot}0$, $2{\cdot}0$ respectively.

The Karman Transverse and Combined Bending Stress for the Walworth Pipe ($\varphi = 0{\cdot}785$).—The author has again selected the Walworth pipe, as it is the only pipe bend for which transverse strain measurements have been taken, thus making it possible to compare the calculated value with the actual test value. The distribution of the longitudinal transverse, and combined bending stress for the outside diameter of the right-hand half of the cross section of the pipe, is shown in Fig. 28—see also Table XVII.

Fig. 26. Ratio of the Karman Transverse Bending Stress to the Maximum Karman Longitudinal Bending Stress for Various Pipe Factors.

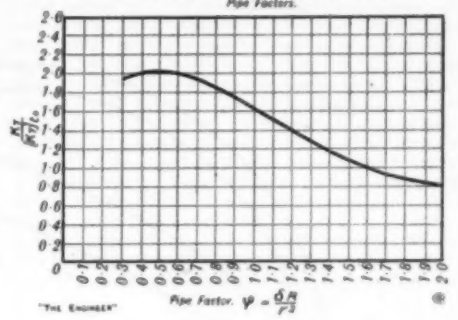
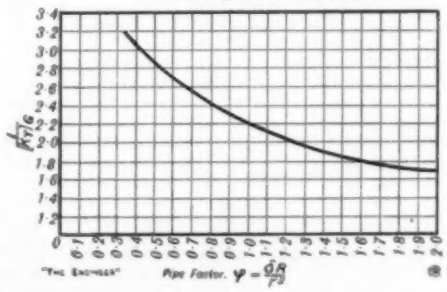


Fig. 27. Ratio of Maximum Combined Karman Stress to the Theoretical Longitudinal Bending Stress. (Max.).



We find that (*a*) the maximum transverse stress at A is 2·1 times the maximum theoretical longitudinal bending stress ; (*b*) the maximum combined

TABLE XVIII.—*Summary of General and Special Formulæ for the Simple and the Karman Bending Theory for the Maximum Value.*
(Pipe fixed at one end and free at the other end.)

1	2	3	4	5	6	7	8	9
	Value.		General formulæ.		Karman correction factor.		Special formulæ for bends consisting of an arc or arcs.	
Case	Required.	Given.	Simple bending theory.	Karman bending theory.	Based on Karman bending theory.	See table or fig.	Simple bending theory.	Karman bending theory.
A	Deflection	Thrust	$\Delta = \frac{H}{E\,I}\int y^2\,ds$ (3)	$\Delta_K = K_H \frac{H}{E\,I}\int y^2\,ds$ (22)	$K_H = \frac{10 + 12\varphi^2}{1 + 12\varphi^2}$ (19)	XV./2	$\Delta = C_H\left(\frac{H}{E\,I}\right) R^3$ (7)	$\Delta_K = K_H C_H \left(\frac{H}{E\,I}\right) R^3$ (22*a*)
B	Deflection	Maximum longitudinal bending stress	$\Delta = \left(\frac{f_b}{E}\right)\frac{2}{d_1}\frac{\int y^2 ds}{y_{max}}$ (6)	$\Delta_K = K_B\left(\frac{f_b}{E}\right)\frac{2}{d_1}\frac{\int y^2 ds}{y_{max}}$ (26)	(*a*) $\varphi = 0{\cdot}3$ to $1{\cdot}5$ $K_B = \frac{9}{\sqrt{10 + 12\varphi^2}}$ (46) (*b*) $\varphi > 1{\cdot}5$ $K_B = \frac{5 + 6\varphi^2}{6\varphi^2 - 1}$ (52)	XV./3	$\Delta = 2C_B\left(\frac{f_b}{E}\right)\left(\frac{R^2}{d_1}\right)$ (8)	$\Delta_K = 2K_B C_B\left(\frac{f_b}{E}\right)\left(\frac{R^2}{d_1}\right)$ (26*a*)
C	Thrust	Maximum longitudinal bending stress	$H = 2\frac{I}{d_1}\frac{f_b}{y_{max}}$ (5*b*)	$H_K = 2K_T\left(\frac{I}{d_1}\right)\frac{f_b}{y_{max}}$ (27)	(*a*) $\varphi = 0{\cdot}3$ to $1{\cdot}5$ $K_T = \left(\frac{1 + 12\varphi^2}{10 + 12\varphi^2}\right)\left(\frac{9}{\sqrt{10 + 12\varphi^2}}\right)$ (47) (*b*) $\varphi > 1{\cdot}5$ $K_T = \left(\frac{1 + 12\varphi^2}{10 + 12\varphi^2}\right)\left(\frac{5 + 6\varphi^2}{6\varphi^2 - 1}\right)$ (53)	XV./4	$H = 2C_T\left(\frac{I}{R\,d_1}\right) f_b$ (10)	$H_K = 2K_T \cdot C_T\left(\frac{I}{R\,d_1}\right) f_b$ (27*a*)
D	Maximum longitudinal bending stress	Thrust	$f_b = \frac{H}{2}\left(\frac{d_1}{I}\right) y_{max}$ (5)	$f_{bK} = \frac{H}{2K_T}\left(\frac{d_1}{I}\right) y_{max}$ (28)	(*a*) $\varphi = 0{\cdot}3$ to $1{\cdot}5$ $\frac{1}{K_T} = \left(\frac{10 + 12\varphi^2}{1 + 12\varphi^2}\right)\left(\frac{\sqrt{10 + 12\varphi^2}}{9}\right)$ (48) (*b*) $\varphi > 1{\cdot}5$ $\frac{1}{K_T} = \left(\frac{10 + 12\varphi^2}{1 + 12\varphi^2}\right)\left(\frac{6\varphi^2 - 1}{5 + 6\varphi^2}\right)$ (54)	XV./5	$f_b = \frac{H}{2C_T}\left(\frac{R\,d_1}{I}\right)$ (10*a*)	$f_{bK} = \frac{H}{2K_T C_T}\left(\frac{R\,d_1}{I}\right)$ (28*a*)
E	Maximum transverse bending stress	Thrust	—	At top of O.S. dia. $[f_{bK}]_1 = \frac{[\psi r_1]_t}{[K_T]_0}\frac{H}{2}\left(\frac{d_1}{I}\right) y_{max}$ (65)	$\frac{1}{[K_T]_0} = \frac{3}{4\varphi}\frac{24\varphi^2 + 1}{12\varphi^2 + 1}$ (57) $[\psi r_1]_t = \left[1 - 2\left(\frac{1}{K r_1}\right)^2\right]$ (64)	24 24*a*	—	$[f_{bK}]_1 = \frac{[\psi r_1]_t}{[K_T]_0}\frac{H}{2C_T}\left(\frac{R\,d_1}{I}\right)$ (65*a*)
F	Maximum combined bending stress	Thrust	—	At top of O.S. dia. $[f_{bK}]_{01} = \frac{1}{[K_T]_0}\frac{H}{2}\left(\frac{d_1}{I}\right) y_{max}$ (91)	$\varphi > 0{\cdot}35$ $\frac{1}{[K_T]_0} = 1 + \frac{18\varphi - 3\left(1 - \frac{1}{4\varphi}\right)}{1 + 12\varphi^2}$ (94)	27	—	$[f_{bK}]_{01} = \frac{1}{[K_T]_0}\frac{H}{2C_T}\left(\frac{R\,d_1}{I}\right)$ (91*a*)

bending stress at A is 2·622 times the maximum theoretical longitudinal bending stress. We find also that the transverse stress at the neutral axis at the outside diameter of the pipe, which is the difference of the transverse bending stress and the compressive stress, is equal to 23,250 lb. per square inch—see Table XVII., Item 19. The actual transverse stress which was obtained from strain measurements and calculated by Professor Hovgaard is 30,280 lb. per square inch, so that the actual transverse stress is 1·30 times greater than the transverse stress at the neutral axis. This may seem a large difference, but as Professor Hovgaard has pointed out, the strain measurements on the transverse section were very difficult to carry out, owing to the great curvature, and as the strain gauge only measured the chord between two punched marks, elaborate calculations were necessary to obtain the elongation of the arc. On the other hand, the actual transverse stress is 2·193 times greater than the maximum theoretical longitudinal bending stress.

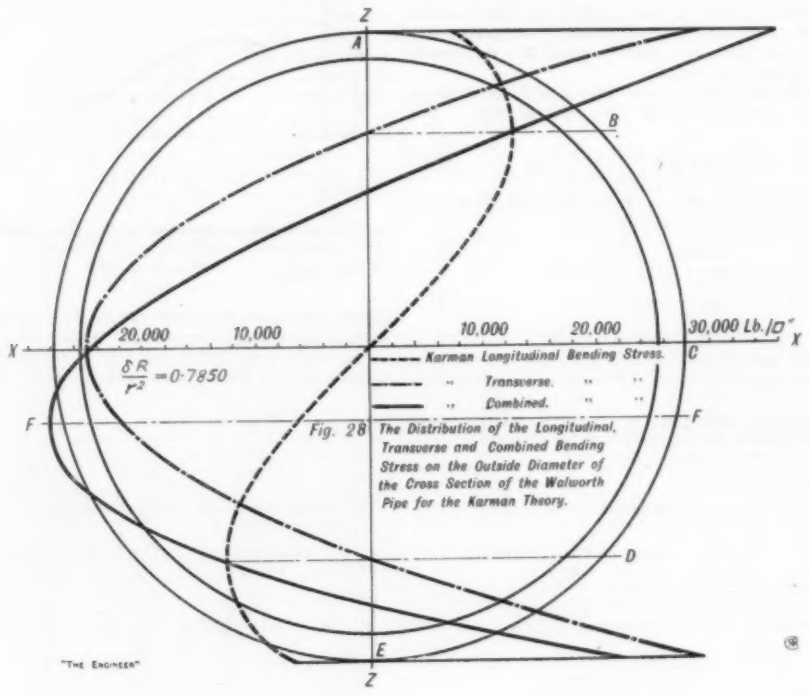


Fig. 28 The Distribution of the Longitudinal, Transverse and Combined Bending Stress on the Outside Diameter of the Cross Section of the Walworth Pipe for the Karman Theory.

Conclusions.

It has been found that the actual deflection, stresses, and thrust agree very closely with the Karman theory, and that the simple bending theory should only be used as a means of calculating values which afterwards will have to be corrected by factors corresponding to the Karman theory. In Table XVIII. a complete summary is given of the author's analysis. Formulæ are introduced which should be used for calculating the deflection, thrust and the various stresses for pipe bends. The Karman correction factors have all been calculated, and are tabulated or plotted for various pipe factors in Table XV. and in a number of figures, which are given in Col. 7, Table XVIII. These correction factors, multiplied by the simple bending theory values, give the Karman bending theory values which should form the basis for the design of pipe bends.

Special formulæ for bends consisting of an arc or arcs are summarised in Col. 8, Table XVIII., for the simple bending theory, and in Col. 9 for the Karman bending theory.

The theoretical factors—C_{II}, C_3, C_4—can be obtained from Tables I., II., and III., and by multiplying these factors by the Karman correction factors—Col. 6, Table XVIII.—we obtain the actual values. This table and the figures in Table XV. should assist the pipe designer considerably, because time will be saved by using the plotted and tabulated values.

As the maximum Karman combined bending stress is considerably greater than the maximum theoretical longitudinal bending stress calculated by the simple bending theory, the former should be used as the basis for the design of pipes.

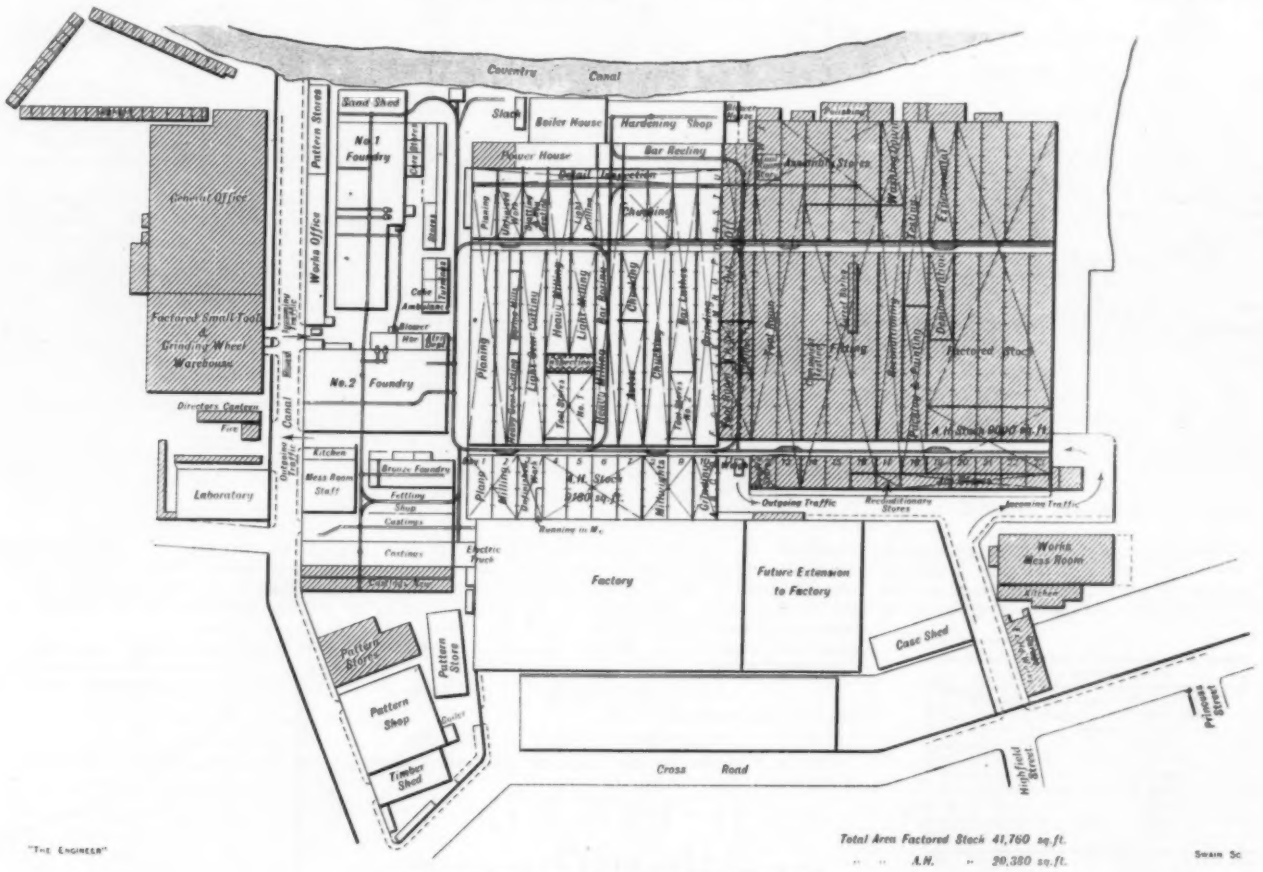
The Edgwick Works of Alfred Herbert, Ltd.

THE activities of Alfred Herbert, Ltd., the machine tool makers of Coventry, have for some years past been divided between two factories separated by a distance of some three miles. The two establishments have now been amalgamated into one, and the following notes give some idea as to how the process of transference has been accomplished without any interference with the programme of production, and indicate the extent of the firm's present equipment.

The present occasion seems appropriate to give some account of the centralisation of the works in the new buildings at Edgwick, Coventry, to which a large part of the plant from the old works at The Butts has been transferred.

The old works at The Butts, more near the centre of the town, were founded in 1889, and there a more or less general style of engineering was carried on—boilermaking, for instance, was an important part of the firm's activities—but from the first, machine tool making was one of the founder's aims, and we believe that the cycle boom of 1893 or thereabouts definitely marked the future policy of the factory. In this way, the foundation of the company more or less synchronised with the advent of mass production in mechanical trades, and a number of specialised machines were produced to assist the local manufacturers to produce bicycles cheaply. Among these was a machine for boring and turning the bottom brackets of cycles, which, it is claimed, was the pioneer of the single driving pulley machine tool, as it was described as requiring no countershaft. By the way, we were impressed by the absence of countershafts at the new works at Edgwick, where practically every machine is belted directly off the line shaft, and we noticed only two belt shifters throughout our tour of the works.

In those comparatively early days, castings had to be bought outside from patterns made within the works, so Mr. Herbert, as he then was, decided to establish a foundry of his own, and bought land at Edgwick, about three miles away on the bank of the Coventry Canal. There a foundry was set to work in 1899, but all the machining operations were still concentrated in the town at The Butts. As the business of the firm grew, however, it was necessary to increase the scope of the Edgwick Works, as The Butts was becoming congested. So gradually a considerable amount of manufacturing was carried on at Edgwick, but the business was hampered by the necessary inter-transport between the two factories.



THE EDGWICK WORKS OF ALFRED HERBERT LTD.

It was consequently ultimately decided to abandon The Butts and to extend the Edgwick Works to accommodate the whole of the firm's activities. Last year Sir Alfred Herbert gave instructions that the move should be made, and insisted that it should be effected without any interference with output. In this connection, we understand that the production of machine tools has suffered no diminution through the process of moving, while no man has lost a single day's work in the shops. Again, the amalgamation of the two staffs has scarcely interfered with their *personnel*.

We are not, here, deeply concerned with the old Butts works—they are now merely a shell—but it must be remembered that they took an important part in the programme by providing an extensive supply of plant and men. We will now pass on to a brief description of the Edgwick Works, as they existed before the final move was decided upon.

On reference to the plan of the works, which we reproduce, it will be seen that certain areas are shaded over. These shaded parts represent the additions which have recently been made. The unshaded part, or branch works as they were, included two ironfoundries and a machine shop, together with a power-house and sundry smaller departments. There was also a separate building, known as the Factory; but this part has not influenced the recent alterations, as it is concerned solely with the manufacture of Coventry dieheads and chucks, milling cutters, ball bearing drilling machines, and such work as bolt-making, which can be ordered in large quantities. The building covers an area of 57,600 square feet, and some idea of its capacity may be gained from the fact that 3000 sets of dies, four to a set, are turned out per week. In the manufacture of these dies forty-three separate operations are performed on each piece, and there are nine inspections, which include a final running trial to provide a specimen screw for microscopic examination.

The major changes which have been made to the original works are the extension of the machine shop to more than double its former size, and the addition of an office building and a warehouse for small tools, &c.

The offices are rather unusual in their arrangement, being entirely set out on one floor, and, in fact, there is only one two-storey building throughout the factory, and that is the works manager's offices adjacent to the foundry on the opposite side of the road to the general offices. Immediately within the entrance to the main offices there are some "cubicles"—we cannot discover a better expression for their description—in which the principal executive officers of the company are housed. Surrounding them there are their subordinates in a wide open space, and the various departments are so grouped that walking about is reduced to a minimum. This policy is carried to the extent that the drawing-office and designing department are on this floor, and are immediately adjacent to the photo-copying plant.

Next door to the general offices there is the warehouse, where are dispensed the small tools, grinding wheels, and so forth supplied by the company, either as its own product or as agents for foreign companies; and beyond that there is the laboratory. In the laboratory there is an extensive equipment for the testing of materials by means of physical and chemical processes, which is employed not merely in the routine examination of the materials passing through the works, but is also at the disposal of customers who require investigations. In this connection it is noteworthy that the firm's laboratory has been certified by the Aircraft Inspection Department.

Now, passing across the road to the productive side of the works, one is faced with the works office, with, on its extreme right, the pattern shop. It is obvious, in such a works as that under review, that pattern-making does not occupy a great amount of space, as its product is turned out in large batches of a similar type, and we noticed that the joinery side of the work carried out in this shop was quite an important part of its activities.

The two foundries have been little changed through the new arrangements. Each of them is equipped with two cupolas and is capable of producing some 80 tons of good castings per shift. The No. 1 foundry is devoted to making comparatively heavy castings, and there most of the work is carried out in loam by hand moulding methods. The sand is brought in by the canal and is immediately mixed and conditioned by machines of the firm's own make. This foundry is served by several electric cranes, with hand-operated cranes in the side bays, and is interconnected with the No. 2 foundry by a line of rails, so that in the event of an unusually heavy cast being required, or any of the cupolas being out of commission, molten metal can be transferred from one foundry to the other.

The No. 2 foundry is specially concerned with lighter castings, and is equipped with a number of pneumatic moulding machines for the production of parts which are required in large quantities. It is noteworthy, in connection with these two foundries, that while in the "heavy" shop the cupolas are served by centrifugal fans, those in the "light" foundry have blowers of the Roots type. There is also a small foundry for the production of yellow metal castings, but as they form a comparatively insignificant part in the construction of machine tools, this part of the works need not be enlarged upon here.

Beyond castings and forgings, which are brought from outside, there is one other essential to the supply of the machine shop, and that is power, and it may be as well to say a few words about that service before proceeding.

In the power-house there are two Robey cross-compound horizontal engines, each driving a 170-kW direct-current generator of 220 volts. These machines were sufficient to supply the works before the new extensions, but have had to be supplemented. So a connection has been made with the local Corporation mains, and three 175-kW converters have been installed to provide 220-volt direct current. There are also two converters for changing three-phase current of 6600 volts down to 220 volts direct current. The general scheme in the shops is to use current at 50 cycles, transformed down to 230 volts single-phase, for lighting purposes; to use 400-volt, three-phase current for such essential services as ventilation and so forth, which must be started by, say, the watchman and then be left unattended; and to use the low-pressure direct current for all other motors.

In the boiler-house there are three Babcock and Wilcox boilers—one of them was in course of erection on the occasion of our visit. Of these two have each a total heating surface of some 5500 square feet, including their superheaters, and a combustion chamber space of 2200 cubic feet. The third boiler is rather smaller and is largely used for experimental purposes. The working pressure is 160 lb. per square inch. All the boilers are fired by coal powdered by "Atritors"

GEAR-CUTTING DEPARTMENT

TURRET LATHES IN TURRET LATHE DEPARTMENT

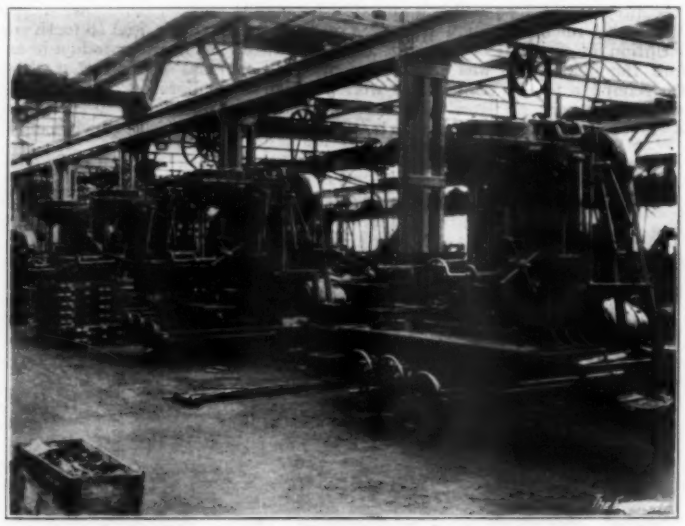
JIG BORING DEPARTMENT

TOOL-ROOM

made by Herbert's, and fed from overhead bunkers supplied with coal from canal barges fed by Ashwell and Nesbit suction apparatus. The ashes are handled by plant of the same make. Besides providing power for driving the machinery of the works, the power-house has to supply heating and ventilating services to the shops, which are effected on the plenum system in the original premises, while the new extensions are served by the Nuvacumette principle. The main offices are heated by hot water radiators.

The machine shop is, of course, the outstanding feature of the new Herbert works and is claimed to be the largest of its kind. It covers, under one uninterrupted roof, a matter of seven acres, and we give a number of views which indicate its extent.

HEAVY BORING MILLS



VERTICAL MILLING MACHINES

It is here that the principal interest in connection with the "moving house" process concentrates, as it was laid down that commercial production should not be interfered with, regardless of any changes. So the first step was to extend the actual building, which then ended with bay No. 10, by the addition of thirteen similar bays. There is, however, one intervening bay, No. 11, of slightly greater width, which is opposite the incoming weighbridge and is served by a very high-speed travelling crane for the distribution of materials to the various departments.

Having provided the new roofed-over premises there arose the problem of re-grouping the machines at the Edgwick and The Butts works so as to make a homogeneous arrangement. A carefully thought-out programme was arranged and, naturally, started with the demolition of the original brick wall bounding bay No. 10. This work obviously could not be carried out with the adjacent machines standing, so they were first moved into the new building and then, with the wall out of the way, there was opportunity for extending the activities of bay No. 9 into No. 10. Similarly machines and general equipment of another bay would be moved from its original position to the extension in such a place that there was room round it for the addition of machines brought up from The Butts, while the space thus liberated was taken by other machines more appropriate to the operations being carried out in the immediate vicinity. In this way the various departments were extended, some by complete removal and others by local growth. Incidentally a number of new machines were added to the equipment and these, naturally, were installed first so as to facilitate the absorption of the men coming from The Butts.

Besides the machine tools the crane equipment required extensive alteration to serve the new conditions and entailed the moving of about thirty cranes. Of the twenty-three bays twenty-one are served by cranes, and there are thirty-five in all, ranging from 10 tons down to 1 ton in lifting capacity. Eighteen of these cranes came from The Butts, eleven were already at Edgwick, and six new ones were bought. All the cranes from The Butts required the span altering, and the necessary material for this purpose was ordered from the makers before the machine was dismantled, and was built in by the Edgwick staff. The existing cranes were, of course, of the proper span, but they had to be moved about to such an extent that only four remain in their original positions. Almost all the cranes are electrically operated and some of the larger sizes have overhead cabs for the drivers.

The whole of these alterations, which have occupied just over a year, have involved the moving of 822 machines. There were 544 machines in the shops when the alterations were started, and there are 898 machines now in the works.

On reference to the plan it will be seen that there are two main avenues connecting all the bays, and each of them is provided with a light railway on which electric battery trucks run. The shop floors consist of 2in. creosoted boards nailed on to creosoted dove-tailed joists embedded in concrete. This gives a pleasant and comfortable surface for working, does not bruise finished work which may happen to be dropped on it, and affords a satisfactory foundation at any point for all except the heaviest machine tools; re-arrangement of plant is thus greatly facilitated. The bulk of the plant consists of single-pulley or electrically driven machines and there are few countershafts in evidence.

The best impression of the arrangement of the shop is gained by entering it by the avenue on the eastern side, where the castings are brought in from the foundry. The first two bays are equipped with planing machines, heavy boring and turning mills, large gear-cutting machines and heavy milling machines, which perform the first operations on the larger castings. In the next two bays extensive use is made of vertical milling machines. Amongst these there should be mentioned the Herbert vertical mill, a fine example of machine tool design, combining great capacity and belt power with ease of operation.

Lathe headstocks, bearing caps and other parts are machined to very close limits on heavy-duty horizontal milling machines, no subsequent hand fitting being necessary.

At the end of bays 4 and 5 there is the jig and tool store, which serves the planing, milling, gear-cutting, and drilling sections.

The boring of lathe headstocks and gear-boxes is carried on in bay No. 6, where the work is mounted in jigs fixed to tables of large area. The boring spindles are carried on uprights on which they are adjusted vertically, the uprights themselves being movable parallel with the sides of the tables. The jigs locate the holes and give the correct alignment to the boring bars, which are driven by flexible couplings from the spindles.

The turret lathe department occupies the next three bays, and is equipped with Herbert capstan lathes, combination turret lathes for chuck work, and hexagon turret lathes for bar work, auto lathes for chuck work, and automatic screw machines for bar work. Combination turret lathes are used for a variety of heavy chucking work made from castings or forgings. The boring and turning of large lathe spindles, made from forgings of 45 tons tensile steel, is a good example of the economy to be effected by the use of these machines. These spindles are machined in one-fifth of the time taken by the previous method of boring on a special machine and subsequently turning in a centre lathe.

At the east end of bay No. 7 there are fourteen engine lathes. Apart from the tool-room, these are the only centre lathes used in the whole establishment, all other lathe work being done on turret and auto lathes. In this connection, we learned that the company has found it to be economic to set up a turret or auto lathe, even if only three or four articles of one pattern are required.

Practically all cylindrical work is finished by grinding in bay No. 10, a very large amount of internal grinding being also done. Holes are finished to very fine limits on Heald Sizematic internal grinders. The design of these machines embodies mechanical, hydraulic, and electric control. On cylindrical work Norton wide wheel grinding machines are largely used. Wheels up to 9in. wide are fed straight into the work with a very slight axial movement to equalise wear. By this method work is finished as accurately and much more quickly than by using narrow wheels and traversing.

STOCK MACHINES IN THE SHOW ROOMS

Some of the external grinding machines are equipped with gauges having indicator dials, which are kept on the work throughout the grinding process, so that the operator knows immediately the correct diameter has been obtained. The ends of the gauges are fitted with stone pads. There are also several machines for flat grinding, and all such surfaces as lathe beds, slides

and so forth are now ground after being planed or milled.

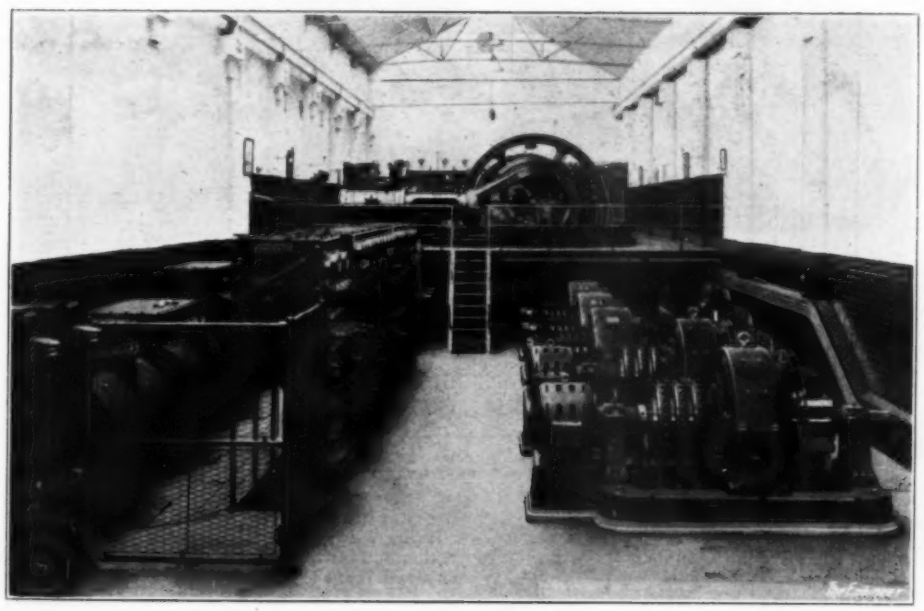
Bar stock, forgings and so forth are brought in by road to bay No. 11, and there there is the cutting-off department, which is equipped with some heavy, inserted-tooth, circular saws, and a battery of hack-saws. The bars are heat-treated to improve their physical characteristics, and are reeled to make them quite straight.

The main tool-room occupies bays Nos. 12 and 13, and there there are made not only the jigs and special tools required within the shops, but also any equipment which customers may order with their machine

PATTERN SHOP

tools. A number of precision jig-boring machines are used in this department.

The next three bays are devoted to what, in these shops, is termed fitting; but we would prefer to call it erecting, for there is practically no fitting in the ordinary sense of the term. All the component parts of a machine are made with such a high degree of accuracy that they go together without the assistance of the file and scraper. The department is provided with special trestles on which the units of the machines are built up, and then these units are assembled to



POWER-HOUSE

form the complete machine. Next to the erecting shop there is a bay in which worn or damaged machine tools are reconditioned by the provision of new parts. Beyond this there is a testing department, where all machines are given a practical trial before leaving the works. The remaining space is devoted to the storage and demonstration of machine tools, made either in the works or by foreign makers for whom Alfred Herbert Ltd., act as agents.

There are no other departments which call for detailed reference, but we may mention the hardening shop, where there are furnaces using coke, gas and electricity for heating purposes; and the works canteen, or mess room, with seating accommodation for 800 men. At the present time about 3000 hands are employed in the works.

ELECTRICITY IN STEEL WORKS.

ELECTRICAL operation is now-a-days adopted in practically all new steel mills in the United States, and 55 per cent. of all rolling mills are thus driven. About 2,000,000 horse-power is already installed for driving main rolls, and this figure increases about 13 per cent. annually, as many older mills change over to electric power. It is even said that the new continuous type wide strip mills could not have been developed without the availability of direct-current motors having flat speed characteristics for driving the individual stands. Several continuous type merchant mills have their stands individually driven by direct-current adjustable speed motors, although the stands are only 8ft. to 10ft. apart and the delivery speeds are as high as 2500ft. per minute. In some cases the several motors are so regulated as to operate in synchronism. The relative speeds of the stands are adjustable, but when once they are set the ratio is maintained continuously. With this flexibility the continuous type of mill has been applied to finishing mills. Two electrically driven flying shears have been put in operation recently. Much progress has been made in applying electricity to mill auxiliaries, with a saving in labour and costs, as in automatic control of screw-downs and the control of soaking pit covers and the ingot buggy by the operator on the soaking pit crane. Motor-driven rollers on tables are being used, even where they stop and start frequently or are required to reverse. Some mills use generating units as large as 30,000 kW and steam pressures of 350 lb. in the boiler plants.

Machine Tool Exhibition, Olympia.

No. I.

THE fourth Machine Tool and Engineering Exhibition, which was opened at Olympia on Wednesday by the Rt. Hon. W. C. Bridgeman, and will remain open until September 22nd, represents a distinct advance in the general character of technical exhibitions in this country, and also, which is really more important, shows that our manufacturers are beginning to appreciate how the designers of machine tools can help them to reduce manufacturing costs and compete against the products of cheap labour abroad.

The first impression which one receives on entering Olympia is relief from that oppressive "frieze" of advertisements blazoning the names of firms which is so common on such occasions. Certainly some of the stands still retain their old style of architecture, but the general object of the exhibitors seems to be to attract attention by the merits of the machinery shown, while the names of the makers are sufficiently conspicuous to make the identification of the individual stands easy. The origin of the change of ideas is fairly obvious, but need not be emphasised here.

The second impression is enforced by the general design of many of the machines exhibited, and is confirmed by conversation with several of the designers on the stands. Only a few years ago machine-tool makers had little hope of selling a machine if it diverged to any great extent from orthodox practice; but at Olympia there are many machines embodying quite radical changes in ideas, and we were told that they find favour with manufacturers. Again, machine tools are becoming very highly specialised, and it is noteworthy that their makers will now go to the pains of designing and producing a machine the market for which is obviously restricted to the requirements of the original customer. For this reason we hope on this occasion to be able to describe some machines of greater novelty than much that has been exhibited in the past.

The only other general impression which it seems appropriate to record in these opening remarks, is the obvious growth in the importance of grinding as a means, not only of finishing pieces of machinery, but also for removing considerable amounts of material —some of the heaviest machines in the Exhibition are grinders.

There is a pleasant innovation, up in the gallery, where there are several machines of historic interest, such as a Maudslay lathe, on exhibit, and we hope that this section may be extended in the future.

A considerable proportion of the exhibits is dealt with in our illustrated Supplement of this week, and below we extend these descriptions.

THOMAS ROBINSON AND SON, LTD.

On Messrs. Robinson's stand the main feature is the adoption of the direct electric motor drive on several of their machines, an arrangement which is now becoming practicable owing to the standardisation of alternating-current supply at 50 cycles in this country. The limitations in motor speeds when using alternating current at the frequency mentioned do not seriously affect such machines as saw benches, tenoners, and morticers, but where speeds higher than 3000 revolutions per minute are required the use of a frequency changer or booster is necessary. By this means spindle speeds up to as many as 6000 revolutions per minute can be obtained. The direct motor drives shown on Messrs. Robinson's stand are applied to a wide variety of machines, and in order to provide the necessary alternating-current a variable-speed motor alternator has been provided. This gives frequencies ranging from 25 to 100 cycles per second with voltages from 110 to 440. The alternator, together with its driving direct-current motor, exciter and switchgear, are all mounted on one base-plate, making a self-contained unit. The driving motor current is taken from the 220-volt direct-current circuit.

The chief advantages claimed for "motorised" machines are that they can usually be arranged in proper sequence to suit the work as it passes through the mill and without the restrictions imposed by line shafting. Belt drives are eliminated completely and there is also a saving in space. We have selected for illustration two of the many machines exhibited by Messrs. Robinson. The first, Fig. 1, is a newly designed three-drum endless travelling bed sander, which is capable of dealing with timber from $\frac{1}{16}$in. to 6in. thick and up to 42in. wide. The first and second sanding drums are directly connected by special flexible couplings to $7\frac{1}{2}$ brake horse-power motors, and the third drum is similarly driven by a 5 brake horse-power motor. The feed gear is driven

from a fourth motor of 3 brake horse-power. The motors are of the British Thomson-Houston Company's "U.K.T." type with squirrel-cage rotors and run at about 1450 revolutions per minute. They and the control gear are all mounted on an extension of the framework of the machine, making a self-contained unit. The starters are of the automatic contactor type, operated by push buttons brought to one panel, a separate emergency push button being provided in a convenient position for the operator to cut out all the motors at once. The sanding drums are of the all-metal type, cast in one length and very carefully balanced. An automatic take-up device is provided in these drums for both the paper and felt coverings. The paper clamps and tensioning devices are operated by excentrics adjusted from the ends of the drums. The drum shafts are mounted on roller bearings carried in swings with a rise and fall adjustment operated by excentrics, hand wheel and worm gearing. The oscillating movement of the second and third drums is performed by an excentric shaft and is transmitted to the drum shafts through self-aligning ball bearings which take the thrust. Exhaust hoods are fitted above the drums and can be quickly removed when required.

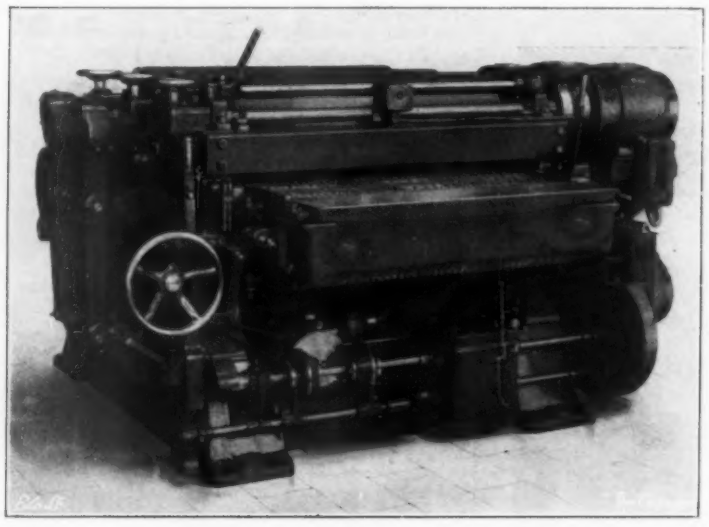


FIG. 1—THREE-DRUM SANDER—ROBINSON

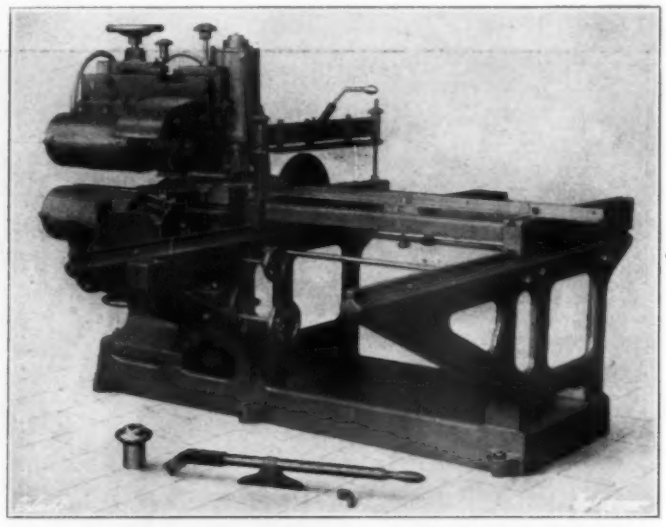


FIG. 2—TENONING MACHINE—ROBINSON

The endless travelling bed is carried in a single piece cast iron frame supported on knife edges by four heavy vertical screws. The knife edge pivots are linked to a hand lever and spring to allow the bed to be instantly lowered and relieve the pressure on the drums in case of emergency. The mounting also allows for the bed yielding automatically to oversize stock. The travelling bed consists of a series of reinforced rubber studded pads fixed to steel slats, which are attached to chains and run on renewable cast iron slides or ways. The pads are easily reversed or replaced in case of wear. This type of bed has a distinct advantage over the wide rubber belts used in some machines which are found to give trouble owing to uneven stretching. Automatic mechanical oil feed is provided for the slides. Tightening gear is provided for the chain and allows each side of the bed to be independently adjusted. The power rise and fall movement of the bed is operated through bevel friction gears and vertical screws, each screw having independent adjustment for levelling purposes. The feed is driven by roller chains from a gear-box giving three rates, viz., 12ft., 17¼ft. and 22½ft. per minute. These can be increased if desired. No link gears are used. A power-driven brush is provided at the delivery end of the machine for cleaning the top surface of the timber, and a second brush on the underside of the endless bed for cleaning the rubber pads.

Fig. 2 represents a direct motor-driven tenoning machine exhibited by Thomas Robinson and Sons, Ltd. This is a general purpose tool for single and double tenoning, top and bottom scribing, cross cutting, trenching, &c. The two horizontal spindles for tenoning and the heavy bottom vertical spindle for heavy scribing and double tenoning carry 4 brake horse-power motors, while the top scribing and cross cutting spindles are driven by 1½ brake horse-power motors. All the motors are of the B.T.H. Company's "shell" pattern with squirrel-cage rotors and are wound to operate on an alternating-current supply at 400 volts, 50 cycles, the speed being 2800 revolutions per minute. Ventilation is supplied by internal fans suitably protected against the entrance of chippings. Each motor is controlled by an Igranic contactor type panel with start and stop push button, and an emergency push button is provided.

All cutter spindles are mounted on heavy ball bearings enclosed in dust-proof housings, and have independent vertical and horizontal adjustments. The horizontal spindles are set to give a slight undercut to the shoulders of the tenons, but the top spindle has a levelling adjustment to enable cross-cut saws to be used on it. The cutter blocks carry full width cutters having a very large shear angle, and not only cut more freely than the double form of cutter block sometimes used, but give a cleaner finish and are easier to set up. A grinding gauge is supplied to ensure the cutters being ground to the correct shape. Single tenons are worked by the horizontal cutter blocks, which can be adjusted vertically. The scribing heads rise and fall with their respective tenoning heads, and in addition are provided with independent vertical and horizontal adjustments. Double tenons up to 5in. deep are cut by a "drunken" or "wobble" saw 15½in. diameter, used in place of the bottom scribing block on the heavy bottom scribing spindle. For cross cutting panels and boards a saw 12in. diameter may be used on the top tenoning spindle, a pair of saw collars being included; alternatively, a separate saw spindle can be fitted behind the tenoning spindles to carry a 15in. saw. The table is 48in. long by 26in. wide and runs on dust-proof rollers, which make it easy to work; it is fitted with adjustable spring stops to determine the distance between the shoulders, thus avoiding the necessity of marking out. Both hand lever and quick-acting excentric cramps are provided, and the fence is arranged to swivel up to 30 deg. for cutting angle tenons or trenches.

Another example of a machine with a "built-in" motor is a vertical two-spindle shaper driven by a squirrel-cage motor of 5 brake horse-power. This machine can be very conveniently run from a frequency changer. It is specially suitable for motor body builders.

EDWARD G. HERBERT, LTD.

Sawing machines, saw-sharpening machines, saw blades and the "Pendulum" hardness testing equipment are the principal features on the stand of Edward G. Herbert, Ltd., Levenshulme, Manchester. In Fig. 3 we illustrate one of the exhibits, a "Rapidor" sawing machine capable of taking in work measuring up to 10in. by 10in. The machine illustrated is arranged for a belt drive. It is exhibited in this form, and also with a motor drive. In the electrically driven example, the motor is mounted on an adjusting frame, fixed to the floor, and drives by belt on to a pulley on the machine, whence the power is transmitted through reduction gearing. In either case the saw frame is reciprocated by a crank and connecting-rod, and is provided with a pair of square slide bars, which move in and out within two long bearings on a bracket swinging about the crank shaft. The pressure of the blade on the work is controlled by a spring, the strength of which can be adjusted by means of a handle applied to the squared end of a shaft projecting through the front end of the pedestal casting. Immediately above this pressure regulator, a plunger-like projection serves to indicate the pressure for which the spring is set. Also projecting from the front end of the pedestal casting just beneath the tray there is a short lever, the operation of which releases a bar used to support the frame in its highest position, when the work is being inserted in the vice. On the return stroke the frame and blade are lifted automatically by means of an oil dashpot, which operates in conjunction with the angular setting of the saw and its frame. This dashpot also comes into action and prevents a sudden fall of the frame, when the work is cut through or in the event of a saw blade breaking. A starting valve is provided on the dashpot, the function of which is to permit a cut to be started on a sharp corner of the work without risk of damage to the blade. In conjunction with the belt-

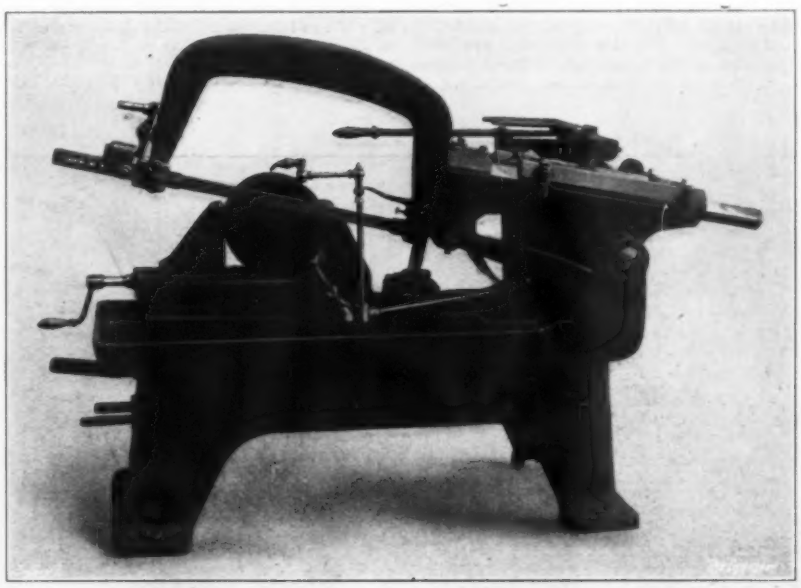


FIG. 3—"RAPIDOR" SAW—EDWARD G. HERBERT

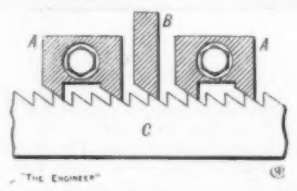


FIG. 4

striking gear there is an adjustable automatic knock-off, which stops the cut when the work has been sawn through or when any pre-determined depth of cut has been reached. The saw is strained by means of a handle applied to a square-ended screw pin on the saw frame. An indicator is fitted to show when the correct tension has been applied to the blade. The work is held in a vice which can be swivelled on the main table when angular cuts are required. The moving jaw of the vice can be swivelled separately to grip taper or irregular work. The vice as a whole, together with a pad which supports the work on the near side of the blade, can be detached from the table in order to allow the work to be bolted directly to the table. In conjunction with the vice there is an adjustable gauge which permits the work to be set for the cutting off successively of equal lengths. A plunger type of pump supplies suds to the saw. This pump is started by the turning on of the tap in the supply piping. An air chamber is fitted to equalise the flow of the suds. The machine can be run at 200 strokes per minute, and with a tungsten high-speed steel saw in the frame can, we are informed, saw 3in. diameter mild steel bars at the rate of one cut per 3¼ minutes.

The Herbert hack saw blade sharpening machine should prove of interest to those who make use of the expensive but in the end economical patterns of saw blades made of high-speed steel. In some cases these blades can be sharpened as many as twenty times. The Herbert sharpening machine is made in two forms, one with an entirely automatic feed of the blade and the other with a hand feed. With the automatic machine as many as 300 teeth can be ground per minute. In both cases the feature of the design is the use of fixed model teeth A A—Fig. 4—of hardened steel with which the grinding wheel B is placed in pitch by means of a screw adjustment. In use the backs of the teeth are at first brought into contact with the model teeth. The blade C is then moved to the left until it is in full contact with the model teeth. During this movement the back of one tooth and the face of the next are ground with a profile copied from the model. By this means, it is claimed, incorrect or accidental contact of the blade with the wheel is avoided and the most efficient cutting angle can be given uniformly to all the teeth.

Buck and Hickman, Ltd.

Several machines of American origin are to be found on the stand of Buck and Hickman, Ltd., London. One of the items exhibited is the Brown and Sharpe automatic rod magazine, illustrated in Fig. 7. In our illustration the magazine is shown applied to a Brown and Sharpe automatic screw machine. When the machine is at work a new rod is automatically fed into the working position as the rod preceding it becomes used up. The device is operated by the machine itself. Its mechanism is connected to the feeding arrangement of the machine is such a way that when the end of the bar on which the machine is working passes a certain point, a ratchet is engaged which feeds a stop forward. At the instant when the last piece is cut off the bar, this stop comes into contact with the starting lever of the machine, and stops the machine. Simultaneously, a clutch is engaged which applies power to the mechanism of the rod magazine. The engagement of this clutch sets in motion a long barrel cam on the rear of the magazine—see Fig. 5. At the outset of its movement this cam trips the mechanism of the magazine, thereby allowing a fresh bar to drop into the feeding position. Further rotation of the barrel cam causes a pusher at the end of the magazine—see Fig. 6—to come into contact with the rod, and to feed it forward through the feeding finger and the machine chuck into the required position. As the follower on the cam comes to the end of its travel, the starting lever of the machine is thrown into engagement, and the machine is again set into operation. The follower then returns to its initial position on the barrel cam and the clutch operating the mechanism of the magazine is disengaged. It is claimed that this automatic rod magazine is of particular advantage on high-speed machines, and that it can be loaded by entirely unskilled labour.

Another production of the Brown and Sharpe works shown by Buck and Hickman is the motor-driven universal milling machine illustrated in Figs. 8 and 9. This machine is claimed to present many unusual features. The driving motor, it will be gathered, is housed inside a compartment in the base. The chief novelty, however, lies in the fact that all the power movements of the table can be controlled from two stations, one, the usual station, in front of the table, and the other, an occasionally useful station, on the left-hand side of the column behind the table. To fulfil this requirement, the control levers are so positioned that they may be reached from either station, or they are duplicated at the two stations. Of chief interest is the duplication of the feed control. At the front of the table a feed selecting box is fixed to the side of the knee. This box enables any one of sixteen different feeds to be selected by means of a single lever movement. The particular feed chosen is exhibited by a direct reading dial, the figures of which are seen through a small window in the box front. A similar feed-selecting box connected to the first by a universal telescopic shaft is fixed to the left-hand side of the column. A lever for engaging, disengaging, and reversing the feeds is also duplicated at the two stations. On the side of the column directly above the second feed-selecting box is a similar box by which the spindle speed is selected. One turn of the handle on this box gives a change of speed and the speed in use is shown by a direct-reading dial. Two series of speeds are available, the second of which is obtained by shifting a back gear lever. Rapid power traverse can be applied to the table in all three directions through a geared drive in which a safety clutch is incorporated. The knee is raised and lowered by a single screw, which is completely protected in all positions. The knee-clamping lever can readily be reached from either operating position. Two arms, instead of the usual single arm, are provided to carry the outer end support for the cutter arbor. The extreme ends of these arms can be tied to the knee by means of a pair of removable links. The cooling fluid for the cutter is supplied at a low pressure by a pump which automatically starts and stops with the spindle. The coolant supply can be delivered either as a flood or in a thin stream. The lubrication of the machine has been given particular attention. All the parts inside the column, including the driving clutch, are automatically lubricated with filtered oil supplied by a pump, the working of which is indicated by a gauge. The inside of the column is enamelled to prevent grit from the casting getting into the oil supply. A second pump supplies oil to all the moving parts of the knee mechanism. The saddle and table bearings are lubricated from an oil well placed in a conspicuous position.

Another example of recent Brown and Sharpe practice to be found on Buck and Hickman's stand is the plain grinding machine illustrated in Fig. 10. The machine exhibited is the smallest of three sizes in which the design is produced. It accommodates 18in. between its centres. With a 24in. wheel it can swing work 12in. in diameter and with a 30in. wheel it can take work up to 6in. in diameter. The drive may be either by belt, Fig. 11, or by a 15 to 40 horse-power motor, Fig. 12. The motor is enclosed in a compartment cast with the base of the machine. This compartment in the belt-driven machine is provided with a front and door and forms a cupboard for the storage of equipment and accessories. In either case the drive is taken on to a main driving shaft at the rear of the bed running at 1000 revolutions per minute. The transmission from the motor to this driving shaft is made by belt with a spring idler pulley to maintain the correct tension—see Fig. 13. The main driving shaft runs in ball bearings and from it power is taken by belt to the grinding wheel spindle and by a second belt to a gear-box from which the rotation of the headstock spindle and the traverse of the table are derived. A starting lever at the front of the machine controls a friction clutch whereby the drive to the headstock and the table traverse can be interrupted. The grinding wheel spindle with its pulley is dynamically balanced and can accommodate wheels from 2in. to 10in. wide. The spindle is mounted in a heavy slide and as this slide moves when the wheel is being fed to the work the tension in the belt driving the spindle is maintained by means of the spring idler pulley. The feed of the wheel to the work can be effected by hand or automatically. Two automatic feeds are provided. The first is employed when the table is traversing and the second when it is stationary. The traversing automatic feed is actuated by the reversal of the table motion and is obtained by means of a ratchet and pawl and a screw and nut. The range of the feed is from 0·00025in. to 0·0045in. by steps of quarter thousandths. The amount of the feed applied at each reversal of the table is controlled from the graduated dial A, Fig. 14, and can be varied while the machine is running. The feed can be automatically thrown out when the work has been brought to size, the provision made for this throw-out consisting of an index dial B graduated to quarter

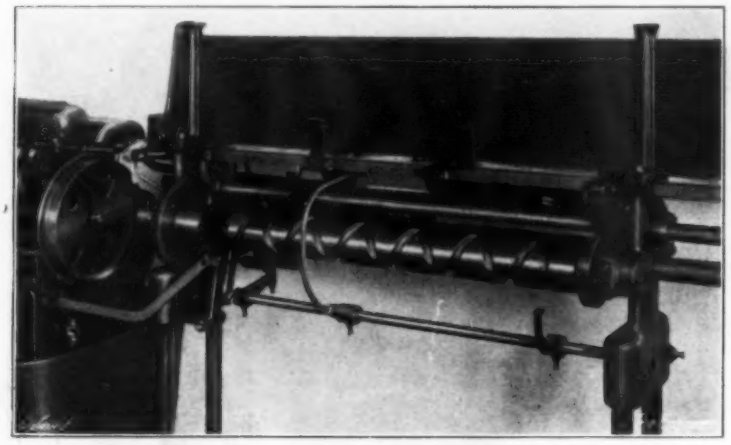


FIG. 5—BARREL CAM OF ROD MAGAZINE

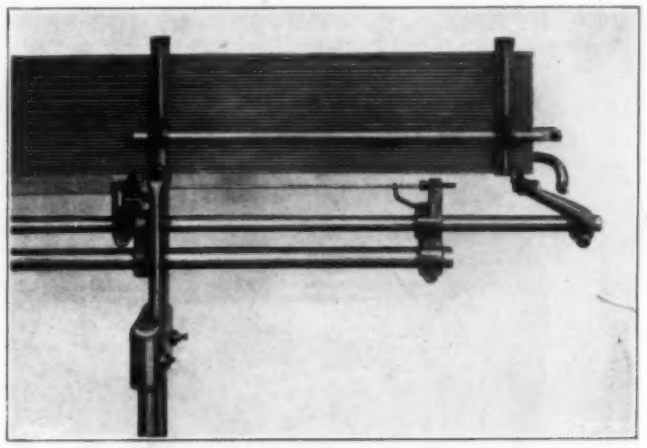


FIG. 6—PUSHER MECHANISM OF ROD MAGAZINE

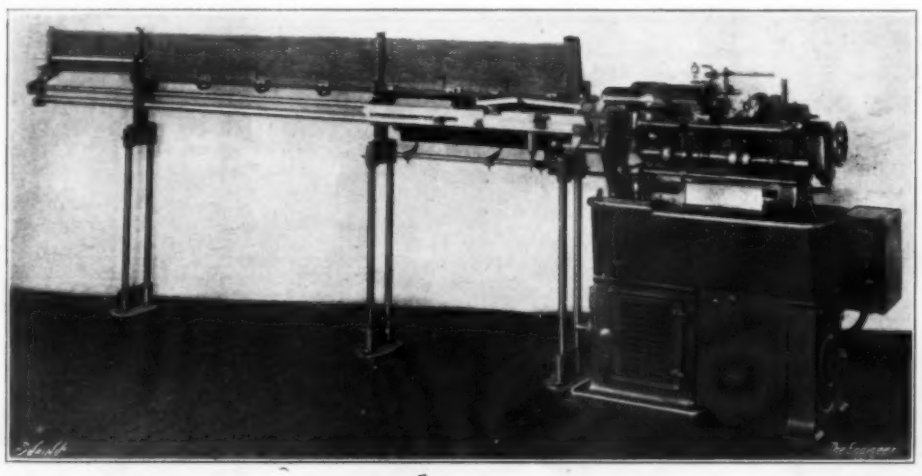
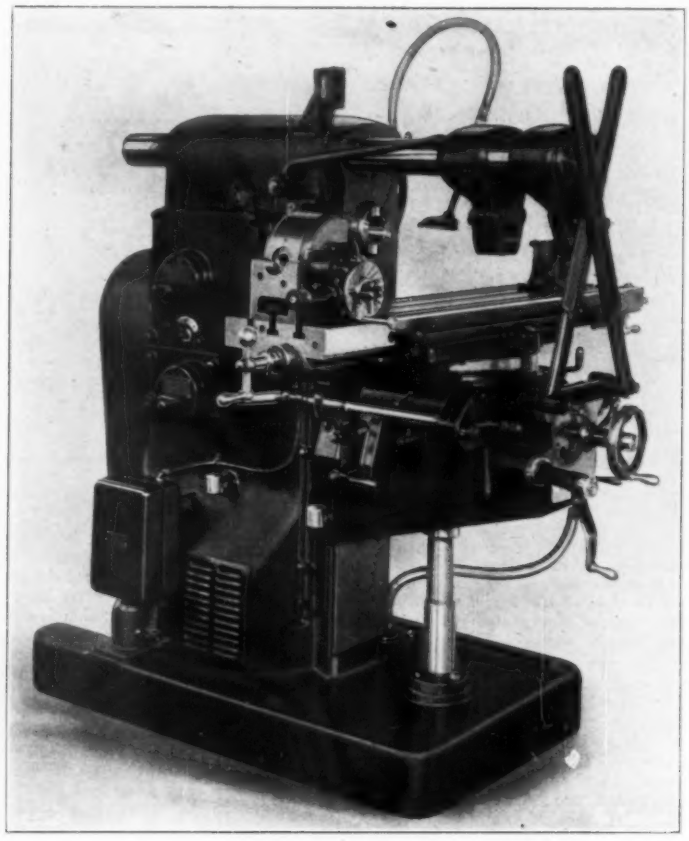
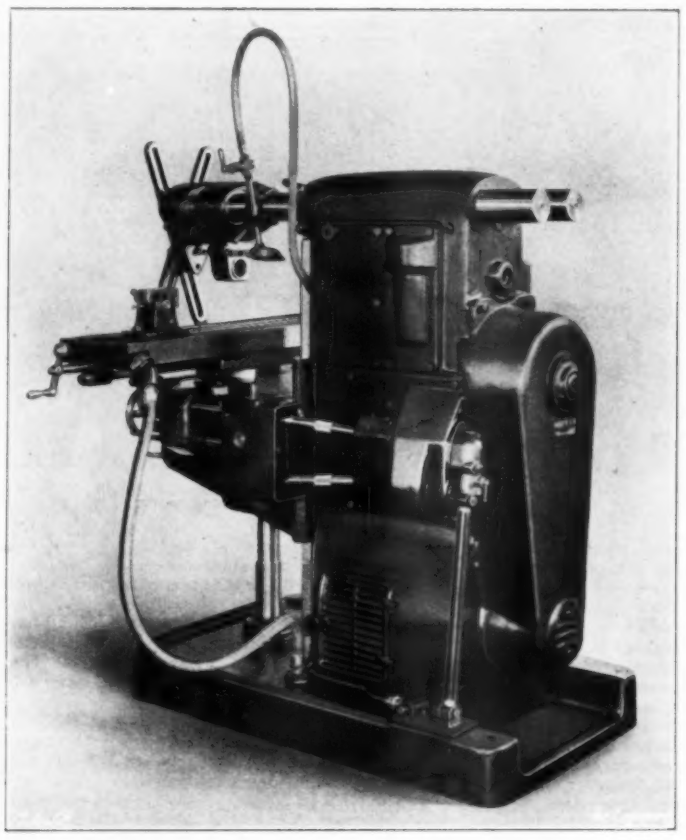


FIG. 7—B. & S. AUTOMATIC ROD MAGAZINE—BUCK AND HICKMAN

thousandths. The same dials A and B serve for the selection and the throwing out of the automatic non-traversing feed. This feed is actuated from the head-stock drive and covers a range from 0·00025in. to 0·0045in. per revolution of the work. The two automatic feeds are selected by means of the push and pull knob C. The dial B is carried by the hand-feed hand wheel D and can be used to provide an adjustable positive stop for the hand feed. The lever E selects the hand or automatic feed. The top portion of the work table swivels on the lower or sliding portion and can be clamped at both ends against a scale reading to degrees of angle or inches of taper per foot. The sliding table is traversed by a rack and pinion. Its stroke is controlled by adjustable dogs on a rack along its front edge. At each end of its stroke it dwells for a period which may be adjusted with the object of giving a full finish to the work at its ends when the table speed is high. At the three lowest table speeds the dwell is automatically suppressed. The table can be traversed by hand from the left-hand wheel shown in Fig. 10. The ball-ended lever shown just above and to the right of this hand wheel has three positions. In one the power traverse of the table is disengaged and the hand traverse engaged. In another the power traverse is engaged and the hand traverse disengaged. In the third the power traverse is automatically disengaged at the end of the table stroke and the hand traverse engaged. The reversing mechanism of the table is fitted with a shock absorber. The work headstock is cast solidly with the swivelling part of the table. Its spindle is driven by belt from a pulley sliding on a splined shaft in the bed. This shaft is in turn driven from the gear-box previously referred to by a torsion shaft, which, in conjunction with the belt drive, is claimed to give an unusually smooth motion to the work spindle. The driving belt to the work spindle is tensioned by means of a spring idler pulley. The speeds of the wheel work and table are entirely independent of each other. There are three grinding wheel speeds, namely, 847, 1000, and 1167 revolutions per minute, which are obtained by changing the pulley on the main driving shaft at the rear of the bed. The work speeds are six in number, extending from 42 to 270 revolutions per minute, and are obtained from a gate change lever at the front of the machine—see Fig. 14. There are nine table traversing speeds ranging from 17in. to 373in. per minute, which are also obtained by the operation of a single gate change lever. The tailstock is bolted to the ways of the swivelling bed. Its spindle can be operated either by a screw and hand wheel or by a spring lever which is fitted with means for adjusting the pressure applied by the spring. Among the additional fittings with which the machine may be provided is an attachment applied to the right-hand end of the grinding wheel spindle whereby that spindle may be reciprocated through ¼in. twenty to thirty-two times per minute, depending upon the spindle speed. This attachment is fitted with a lever whereby it can be made inoperative.

The new type of Gleason spiral bevel gear generator illustrated in Fig. 15 is also to be found on Buck and Hickman's stand. This machine can be used to cut spiral bevel gear wheels up to 11in. in pitch diameter. It is a single-purpose machine; that is to say, the machine is supplied to produce one style of gear only, and in each case has only one rate of feed and one cutting speed. The generating principle is the same as that used on earlier Gleason machines, and the cutters employed are also identical. The generating motion is obtained by means of a crown gear and segment. The cutter is carried on an upright and has a lateral movement so that the cutter may clear the work during the indexing period. The cutter spindle is mounted on ball bearings and is driven by a motor mounted on the cutter head. A second motor of the built-in type provides power for the indexing and generating motions. An automatic stop is provided to break the current when the last tooth has been cut on the work. This stop can be set for any number of





FIGS. 8 AND 9—B. & S. MOTOR DRIVEN UNIVERSAL MILLING MACHINE—BUCK AND HICKMAN

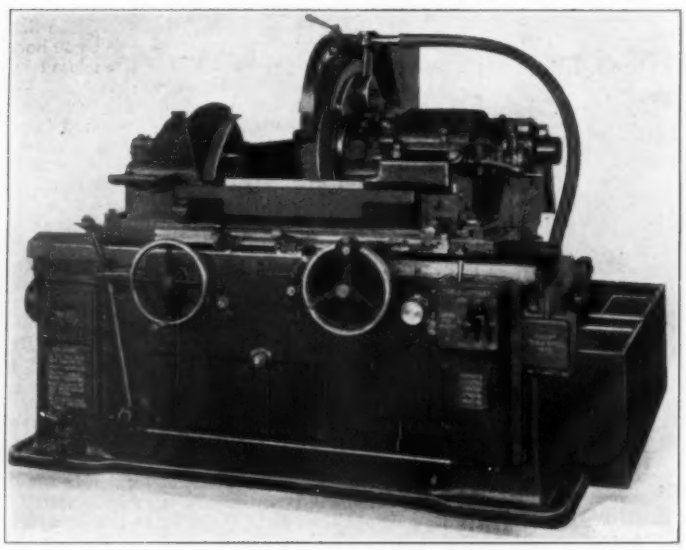


FIG. 10—B. & S. PLAIN GRINDER—BUCK AND HICKMAN

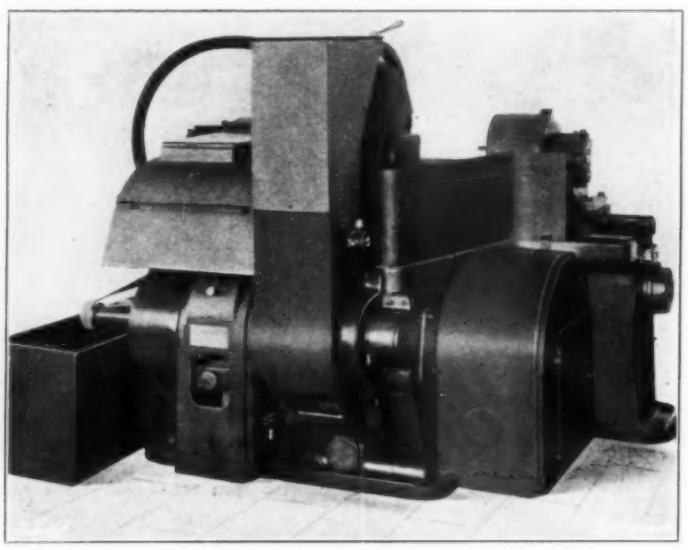


FIG. 11—B. & S. BELT DRIVEN GRINDER—BUCK AND HICKMAN

teeth and its use enables the operator to attend to several machines simultaneously. The chips from the work drop into a basket which, when full, tips about, swivels, and drops its contents into a second basket, which can be removed from the rear of the machine. The lubricating and cutting oil supplies

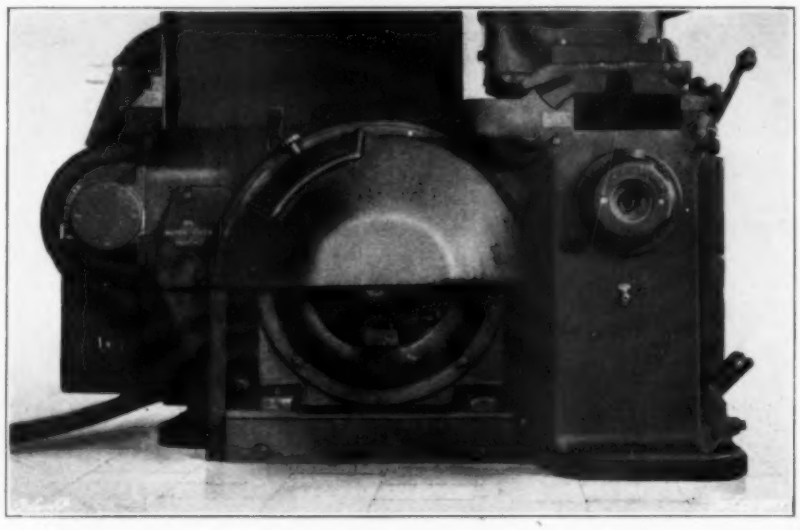


FIG. 12—B. & S. MOTOR DRIVE FOR PLAIN GRINDER—BUCK AND HICKMAN

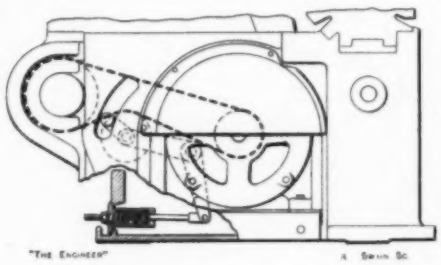


FIG. 13—BELT TENSIONING MECHANISM

are also replaced from the rear, and as a result there is no loss of production time or interference with the work caused by the removal of the chips or the replacement of the oil. The machines can be set up in batteries by using spacers to join them together.

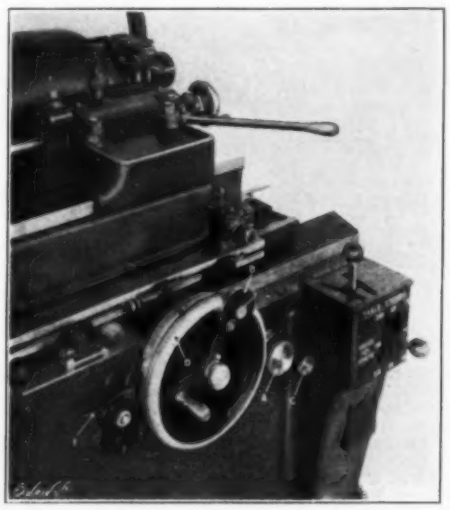


FIG. 14—SPEED AND FEED CONTROLS

WADKIN AND CO.

An extensive range of woodworking machinery is exhibited by Wadkin and Co., of Leicester. Two of the exhibits, namely, the wood turning lathe shown in Fig. 16 and the band saw illustrated in Fig. 19, are of particular interest, in that in both cases the driving motor is directly incorporated in the design of the machine.

The wood turning lathe—Fig. 16—is made in three sizes, namely, with 6in., 8in., and 10in. centres, and suitable for turning lengths up to 3ft. 4in., 5ft. 4in., and 7ft. 4in. respectively. The lathe exhibited is of the 8in. pattern. The bed of the machine is supported at one end on a leg and at the other is bolted to the headstock casting. It is provided with a gap and filling piece at the headstock end which, in the 8in. size, enables diameters up to 2ft. 4½in. over a length of 6½in. to be turned. The headstock carries a 1½ horse-power motor running at 950 revolutions per minute. From the motor power is transmitted to the lathe spindle by means of a belt and a four-speed cone. The belt is shifted by means of a lever mounted outside the headstock. The driving motor is mounted on a pivoted base-plate which can be adjusted to give the required belt tension. When the belt is being shifted for a change of speed the motor base-plate is slightly raised by applying pressure to a foot lever. The four spindle speeds are 240, 600, 1250 and 2880 revolutions per minute. The motor is started and stopped by a push button control slung beneath the bed. The headstock spindle is screwed at the front end to take a face-plate and is also bored to a Morse taper to take a centre. In addition the spindle is extended to the back end, where it is threaded for the receipt of another face-plate—see Fig. 17—whereby, with the aid of a tripod carrying a hand rest, work of large diameter may be turned. The hand turning rest can be fixed at any point along the bed, clamping being effected by means of an excentric lever handle. In addition to this hand rest a travelling rack slide rest—see Fig. 18—can be fitted to the bed. This rest has a movement along the bed controlled by a machine-cut rack and pinion and a cross motion controlled by a square-threaded screw. The tool post is carried on a graduated swivel base, whereby angular work may be done accurately. The tool is carried within a slot in the tool post and is supported at the correct level by means of a series of spacing collars. The uppermost of these collars is formed with a spherical seating which in conjunction with an adjustable tool piece, enables the tool to be set at the best cutting angle. Over the hand rest and the travelling slide rest work up to 13in. in diameter can be turned. The tailstock is fitted with a self-discharging centre and can be set over for taper turning.

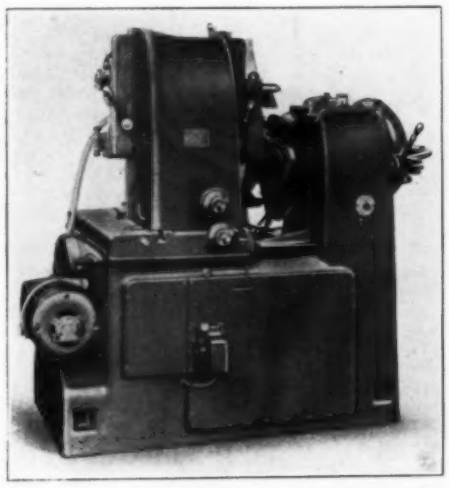


FIG. 15—GLEASON SPIRAL GEAR GENERATOR

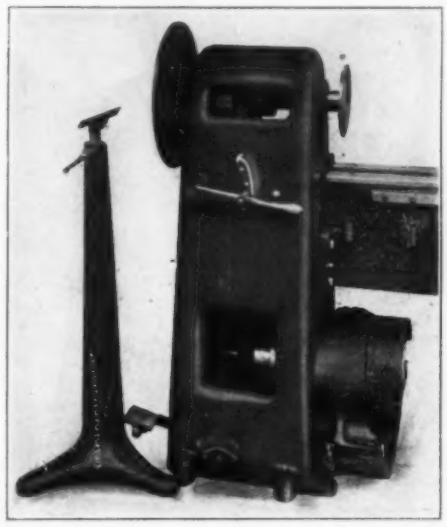


FIG. 17—LATHE ARRANGED FOR OUTSIDE TURNING

The electrically driven band-saw illustrated in Fig. 19 has saw wheels 30in. in diameter and 1¾in. wide. It can take a saw up to 1¼in. in width and lying between 16ft. and 17ft. in length. The wheels are very accurately balanced and run on spindles carried on dustproof ball and roller bearings. The edges of the saw wheels are covered with rubber, which is vulcanised on as distinct from the usual practice of applying the rubber in the form of bands which are stuck on. The upper saw wheel is supported by a casting working in a vertical slide to which an automatic saw tensioning force is applied by means of a sensitive compression spring. The bottom saw wheel carries directly in its spindle a 3 horse-power fan-cooled motor. The motor is protected from saw-dust and an adjustable brush is provided to keep the face of the saw wheel free from dust and chips. By means of a quadrant seated in machined ways the table can be canted through 45 deg. to the operator's right and 5 deg. to the left. This quadrant is struck with a radius centred at a point on the surface of the table. When, therefore, the table is canted it is unnecessary to remove the centre plate round the

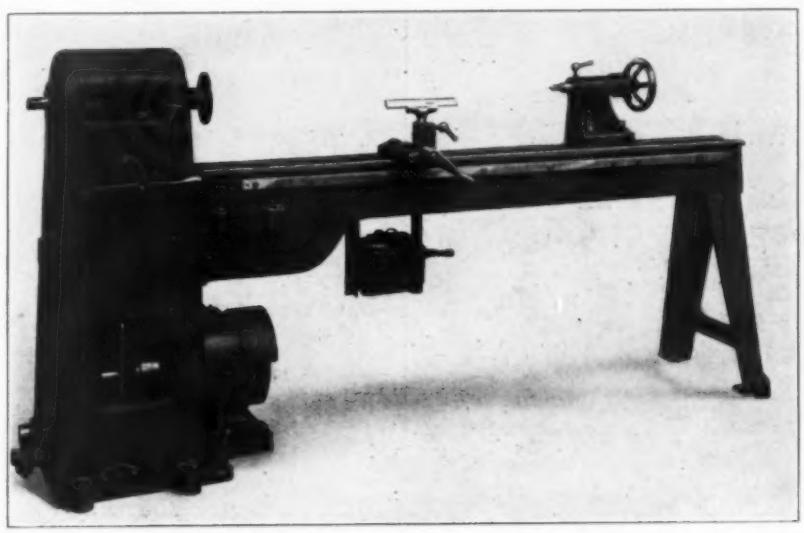


FIG. 16—MOTOR-DRIVEN WOOD-TURNING LATHE—WADKIN

saw, as is the case when the table is mounted to tilt on a pin, the axis of which is several inches below the table surface. A balanced, ball bearing anti-friction guide for the saw blade is fitted above the

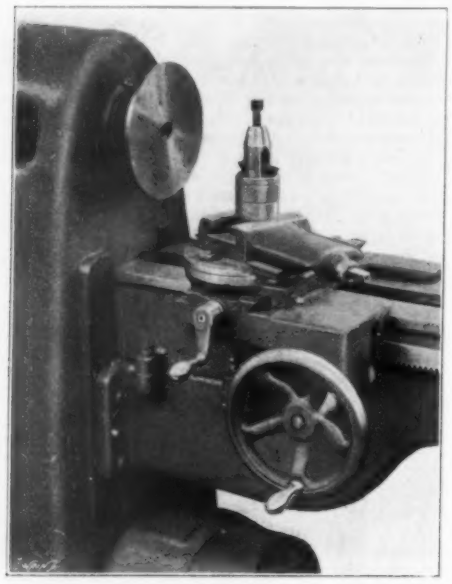


FIG. 18—TRAVELLING RACK SLIDE REST

table and a hardwood guide below it. The tracking device for correcting the position of the saw blade on the wheels is actuated by a handle situated just below the top saw guard and may be operated while the machine is running. The wheels are fully guarded,

FIG. 19—BAND-SAW—WADKIN

and hinged wooden guards are fitted on both sides of the saw blade. The only portion of the saw blade which is exposed is the working part between the table and the top saw guide. In this space work up to 14in. in height can be accommodated.

(To be continued.)

THE Railway Returns for 1927 show that six new engines—all on the London and North-Eastern—were built on capital account during last year, and that 664 engines were renewed. Of the latter, the Southern had 16, the Great Western 135, London, Midland and Scottish 385, and the London and North-Eastern 128. The L.M.S. renewals included eight locomotives, purchased from the Disposals Board, and the L.N.E. included 51 such purchases. The four grouped companies made heavy repairs to 9441 engines, of which the L.M.S. had 4516 and the L.N.E. had 3025; and light repairs to 7510, of which the L.M.S. had 4243. At the end of the year the Southern had 432 engines under or awaiting repair; the Great Western had 680; the London, Midland and Scottish, 877; and the London and North-Eastern, 773. There were 30,234 wagons completely renewed. The L.M.S. had 17,835 and the L.N.E. had 8360; whilst heavy repairs were executed on 121,217, of which the L.N.E. reported 57,710 and the L.M.S. 43,789.

Obituary.

HENRY MATTINSON.

BY the death of Mr. Henry Mattinson, the Manchester Corporation has lost a very valuable and upright servant and the engineering profession is deprived of a worthy representative. Mr. Mattinson died on Saturday last at Salcombe, Devon, where he was taking a much-needed rest from his arduous duties as general manager and chief engineer of the Manchester tramways. He was only fifty-one years of age, but his health had been a source of anxiety for some years, as a result of the war. Before he went to Manchester as assistant engineer to the tramways department of the Corporation in 1901, Mr. Mattinson had been in the employment of the Corporations of Hull and Wolverhampton. He served his articles as a civil engineer in Bradford, Yorkshire. In 1904 he was appointed permanent way engineer to the Manchester tramways, and subsequently civil engineer to the system. On the retirement of Mr. J. M. McElroy in 1922, he was promoted to general manager of this system, which is one of the largest and most efficient in the kingdom.

There are few more trying posts for public officials than that of a manager of tramways at the present time, when the problems connected with road traffic in the chief centres of population are almost overwhelming, but Mr. Mattinson filled his post in a remarkably efficient and successful manner. Although he was a firm believe in tramways for dealing with passenger traffic in large cities, he did not disregard the value of buses for certain classes of work, and during the last three or four years developed the use of the express motor bus for connecting outlying districts. Ninety buses are now in use for this purpose. The length of tramways worked by the Corporation aggregates 281 miles of single track, of which 165 miles are owned by the Corporation, 54 miles are leased to the Corporation, and on 62 miles the Corporation has running powers. The gross capital expenditure on the tramways system up to last year was £3,751,106, the population served was approximately one million, the car miles travelled during the year 22,783,254, and the passengers carried 310,559,874.

During the war Mr. Mattinson rendered very valuable service to the Egyptian Expeditionary Force, when, as Major in the Royal Engineers, he was responsible for the construction of over 100 miles of light railway between Gaza and Aleppo, and after the defeat of the Turks in 1918 he took over the restoration of 600 miles of captured lines. For his services in this connection General Allenby mentioned Mr. Mattinson in his dispatches.

He was a man of untiring energy and much inventive ability. Some little time ago he propounded an original scheme for an underground railway system for Manchester, by means of which the various existing railway termini could be connected by underground lines to a central station under the city. This scheme has not yet come up for consideration by the City Council. In conjunction with a Bristol firm of engineers Mr. Mattinson recently designed a device for automatically printing and numbering tramway tickets. This machine is now being tested on the Manchester system.

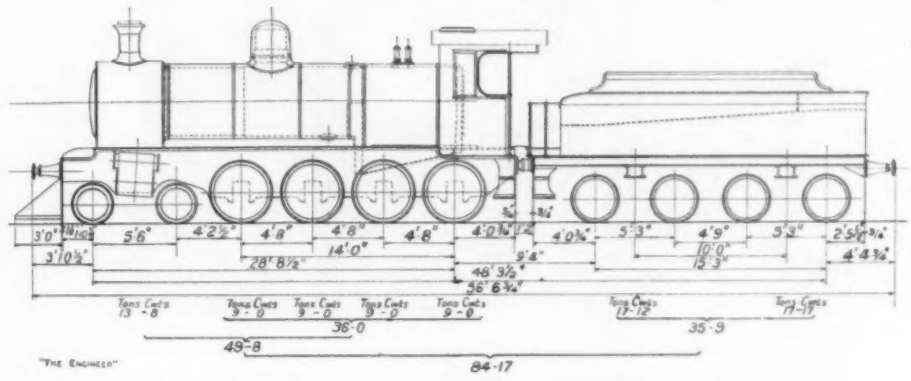
Mr. Mattinson was an associate member of the Institution of Civil Engineers, a member of the Institution of Municipal and County Engineers and of the Institute of Transport. He was a member of the Executive Council of the North-Western Section of the latter institution, and took a great interest in its proceedings.

Eight-coupled Superheated Locomotives for Ceylon.

Two 4–8–0 type superheated engines and tenders have recently been constructed by the Hunslet Engine Company, Ltd., of Leeds, to the order of the Crown Agents for the Colonies, for service upon the Ceylon Government Railways. One of these engines is illustrated on page 258, and a weight diagram is given herewith.

The engines, which are of a new design and for 5ft. 6in. gauge, are intended for service upon the northern lines, and they have been designed to comply with the restrictions as to weight and length imposed by those lines. The maximum axle load permissible is, for example, only 9 tons per coupled axle, and the length of the engine had to be such that it could be manœuvred upon a 50ft. turntable. Duplication of certain parts—notably the boiler—with existing types has been effected, and, as will be seen by the accompanying particulars, the restrictions imposed have been successfully met. The superheater fitted is of the latest M.L.S. type.

The tender is carried upon two bogies of the Sheffield



CEYLON GOVERNMENT RAILWAYS—EIGHT-COUPLED LOCOMOTIVE

and Twinberrow type, similar to those now being supplied for Ceylon Railways' rolling stock. Electric light equipment by J. Stone and Co., Ltd., is fitted.

The leading dimensions of engine and tenders are as under:—

Gauge of railway	5ft. 6in.
Cylinders—Diameter	17in.
Stroke	22in.
Diameter of coupled wheels	4ft.
,, bogie wheels (engine)	2ft. 6in.
,, ,, (tender)	3ft.
Rigid wheel base (engine)	14ft
Total wheel base (engine)	23ft. 8½in.
,, ,, (engine and tender)	48ft. 3½in.
Height from rail to top of chimney	13ft. 2¼in.
Extreme width	9ft. 8½in.
Heating surface—	
Small tubes	540 square feet
Large tubes	319 ,,
Fire box tubes	117·5 ,,
Total (evaporative)	976·5 ,,
Superheater elements	201 ,,
Total	1177·5 ,,
Grate area	23·5 square feet
Working pressure	170 lb. per sq. in.
Tank capacity	2700 gallons
Fuel capacity, coal	4 tons
Weight, empty.—Engine	44 tons 16 cwt.
Tender	19 tons 10 cwt.
Weight in working order.—Engine	49 tons 8 cwt.
Tender	35 tons 9 cwt.
Total weight of engine and tender in working order	84 tons 17 cwt.
Total weight on coupled wheels	36 tons
Maximum axle load	9 tons
Tractive effort at 75 per cent. boiler pressure	16,888 lb.
Ratio—Adhesive weight/tractive effort	4·77

PROGRESS AT SHAWINIGAN FALLS.

PRELIMINARY to one of the most important power development projects ever planned in Canada, the Shawinigan Water and Power Company, of Shawinigan Falls, Quebec, now has fifty engineers carrying out an extensive and thorough water power survey of the upper reaches of the St. Maurice River, which is situated in the Province of Quebec. This survey, which will probably occupy about two years, follows upon the agreement recently entered into between the Shawinigan Company and the Quebec Government for the development of a number of sites on the St. Maurice River. It is estimated that eventually there will be developed about 1,000,000 horse-power from the sites now being surveyed. The proposed expenditure of the company is estimated at approximately 50,000,000 dollars.

In the meantime the Shawinigan Company is installing new generators in one of the plants at Shawinigan Falls, for the development of an additional 80,000 horse-power, which will give the company a total output of 764,000 horse-power. Two units of 40,000 horse-power each are being installed. It is expected that the first unit will be in operation by the end of this year, and that the second unit will begin operating some time in 1929. The expansion has been designed to meet normal increases in the demand for power in the territories served by the company.

Shawinigan Chemicals, Ltd., the big chemical subsidiary of the Shawinigan Water and Power Company, operating the Electro Products Company, Ltd., and the Canada Carbide Company, Ltd., at Shawinigan Falls, are also making extensive additions to plants. The largest piece of work is the erection of a rotary lime burning plant consisting of two rotary lime kilns equipped with pulverised coal burning equipment and the most modern type of elevating and conveying machinery. The cost will be about 300,000 dollars. The company is also spending approximately 150,000 dollars on new equipment for the quarry at Bedford, Quebec. This will consist of electrically-driven crusher, screens, elevators and conveyors to provide 1000 tons daily of crushed limestone to the rotary lime kilns at Shawinigan Falls.

Railway Matters.

WORK has been started on the Clarence River Bridge at Grafton, New South Wales. It will be one of the largest railway bridges in Australia, and is to cost £539,900. It will include an opening bascule span and have a total length of 1500ft.

IN view of the retirement of Mr. J. Hunter, the locomotive works manager at Eastleigh, Southern Railway, Mr. E. A. Turbett, the manager of the locomotive works at Brighton, has been removed to Eastleigh, and Mr. J. J. Ellis, the assistant manager at Brighton, has been promoted to succeed Mr. Turbett.

THE work of strengthening of the Jhelum Bridge on the North-Western Railway of India up to the required standard of loading has now been practically completed. The method adopted for strengthening the bridge consisted of adding a third girder, midway between the existing ones, and reinforcing the latter.

SPEAKING in Southwark recently, after an inspection of that borough's method of disposing of refuse, Mr. S. Susumura, the representative in London of the Japanese Ministry of Railways, said that Japan owned many subsidiary undertakings as a result of which the health, welfare and housing of their railway employees was a matter of the greatest importance to them. In these subsidiary undertakings, as well as in railway administration, Japan took Great Britain as its model.

SOME time ago the Indian Railway Board arranged with the railway companies there that all saturated engines should be converted to the use of superheater steam within five years. The economies therein had been so satisfactory that in 1926 it was further proposed that the work be completed in 1929–30. The replies received by the Board warranted that body, in consultation with the consulting engineers, preparing drawings for the conversion of all the B.E.S.A. locomotives, and it is now anticipated that the work of conversion of saturated locomotives will be completed by 1929–30, as intended.

THE railway bridge over the Umfolozi River, Zululand, has twice been completely washed away, and to obviate similar occurrences in future, the Administration's engineers have prepared plans for a new bridge at a fresh site, which necessitates a deviation and tunnel for the line. The new bridge will, according to the *South African Engineer*, be one of the longest in South Africa, consisting of eleven 150ft. spans, and will be considerably higher from normal water level than the old. It will provide accommodation for road traffic as well, by means of cantilever brackets from the main structure. The cost is estimated at £260,000 and tenders are now being invited for the structure.

IT will come as a surprise to many to know that out of the 194½ millions of assets that British railway companies had to their credit at the end of 1927 no less than 23½ millions, or 12 per cent., were in the stock of stores and materials they held. The amounts possessed by the four grouped companies respectively were:—Southern, £2,508,381; Great Western, £3,438,212; London, Midland and Scottish, £10,379,584; and the London and North-Eastern, £6,715,840. These figures become more remarkable when it is seen that, despite the fall in the prices of materials, these totals are higher than they were when grouping began. In 1923 the total for all the railways was 21¼ millions; in 1925 it was 24½ millions.

THE death of the second guard concerned in the collision at Ancoats, Manchester, on July 29th, following on the fireman being killed in the Shepreth level crossing disaster of August 17th, brings, with the two enginemen killed at Pinwherry on July 9th, when their goods train got out of control and was derailed, the number of trainmen killed in train accidents this year to five. This, when compared with only one trainman killed in 1927 and only one in 1926, may seem a large number. The casualties under this heading vary, however, considerably. In 1925 there were thirteen fatalities, in 1921 there were ten, whilst in 1923 there were nine. Thus, during the seven years ended December 31st, 1927, there had been forty-four trainmen killed in train accidents, or an average of 6·3 per annum.

THE Dundalk, Newry and Greenore Railway was originally the Dundalk and Greenore, and was authorised in 1863. It served to connect the Irish North-Western Railway—now part of the Great Northern of Ireland—from Clones, at Dundalk Quay Station, with Greenore. In 1873 a line from the Great Northern at Newry to Greenore was sanctioned, and the name of the company altered to the Dundalk, Newry and Greenore. Although ostensibly an independent company, with its own locomotives and rolling-stock, it actually was owned by the London and North-Western and has, in consequence, become part of the London, Midland and Scottish. In its issue of August 22nd *The Times* stated that its Belfast correspondent reported that the negotiations for the purchase of the line by the Great Northern of Ireland had been satisfactorily arranged. Whilst the London, Midland and Scottish Company stated the following day that the report was "unauthorised and incorrect," the denial does not necessarily mean that the transfer will not come about.

A VERY effective form of economy is the conversion of double lines, where the traffic has diminished, into single lines. The economy is secured by less track having to be maintained, fewer signalmen, owing to the line then being worked by a token system, and less signalling as the token system is its own protection. The first line to be so converted in this country was the Bedford and Hitchin, of the Midland. That was part of that company's route to London, as its trains travelled over the Great Northern from Hitchin, but its importance departed when the Midland, in 1868, opened its own line from Bedford to London. When, during the war, track material was urgently required overseas, a considerable mileage of double line was altered to single. Much of that has been restored, but a large amount, *e.g.*, between Bedford and Northampton, still remains single. These observations are prompted by the Dublin correspondent of *The Times* reporting that the whole of the line between Dublin and Galway is to be single tracked and that other lines to be converted are those between Limerick Junction and Killonan, Athlone and Roscommon, and Mullingar and Longford.

Notes and Memoranda.

IT is estimated that 550,000 horse-power will be added to the hydro-electric resources of Canada during the present year.

ACCORDING to Professor H. Bohle no other saucepans and steamers but those made of solid nickel should be used in any large kitchen.

ACCORDING to the *Coal Age*, to displace fuel oil and natural gas in the United States nearly 139,000,000 tons of coal would be needed each year.

THE Chinese Ministry of Industry, Commerce and Labour is urging farmers throughout the country to sink wells, by modern methods, to depths of 200ft. or more.

THE total forest area of Canada is 1,200,000 square miles, but only 38 per cent. of this area carries any timber of merchantable size which is at present accessible or likely to become accessible for many years.

THE latest bulletin issued by the Department of Scientific and Industrial Research, of interest to the building trades, deals with the Effects of Moisture Changes on Building Materials. It may be obtained from H.M. Stationery Office, price 1s.

THE American Bureau of Fisheries has found that the action of oleic acid on carbonate of copper gives a compound which when diluted with the proper solvents produces a liquid possessing the ideal properties for the treatment of nets and twines that are to be immersed in sea water.

BORIUM, made in California, is intended to be used as a substitute for diamonds in drilling. It is a manufactured product with a hardness between that of a sapphire and a diamond. Although it cannot be melted in the hottest part of the oxy-acetylene flame, other metals such as iron and steel can be brazed or fused to it. It cannot be softened by any kind of heat treatment, but can be decomposed by the prolonged heat from an electric arc. It is insoluble in any single acid, hot or cold, and can neither be machined nor ground.

COMMENTING on the explosion of a flexible metallic pipe used to convey steam from shore boilers to an oil tanker in the tideway, the Engineer Surveyor-in-Chief, Board of Trade, says: Flexible pipes are frequently used to make connections between a ship afloat and the shore, and if care is exercised to ensure that the parts of which the pipe is constructed are not unduly strained, such an arrangement usually works satisfactorily. The support for such a pipe should be in the form of a cradle suitably slung from above or some such contrivance as will prevent bending of the pipe to a small radius. In the case dealt with in the report, the method of supporting the pipe was not a suitable one.

IN an article concerning the cofferdams used in the construction of the piers for the Hudson River Bridge, which appears in the *Engineering News-Record*, it is stated that some very interesting data were compiled concerning the actual stresses on different timber struts, calculated from measurements taken of deflection and of shortening under compression. These measurements were taken between copper tacks on each strut before and after unwatering the dam. The tacks were spaced about 30ft. apart on a full-length timber, and all measurements were made very accurately with a steel tape, corrections being made for the temperature. The results of the data compiled showed that below the level of the submerged backfill the actual pressures were less than hydrostatic, while above this level they coincided with the hydrostatic pressure.

ACCORDING to the *Chemical Trade Journal*, an interesting process for the production of high-viscosity oils from oils of low viscosity by the action of the silent electrical discharge is now being worked on the commercial scale in Germany. The process is equally applicable to animal, vegetable and mineral oils, but it is obvious that the last mentioned will be employed, as they are so much the cheaper to-day. By varying the duration of the treatment, lubricating oils of any desired consistency may be obtained, but in practice an intermediate stage of polymerisation is aimed at as prolonged treatment is uneconomic. It is stated that with these oils, viscosities of 100 Engler units are obtained at a temperature of 100 deg. Cent., as compared with mineral oils which have only viscosities of one to two Engler units at this temperature. Another field of application for these Voltol oils is in the production of lubricating oil emulsions in which they can replace either wholly or partially the tar distillates.

THE heating of the soil in greenhouses and hotbeds by means of hot-water pipes or manure has, says *Nature*, been universal until quite recently. In 1923 G. Jacobson, the electrical engineer at Aker (near Oslo) in Norway, noticed that the grass over a buried electric cable near the power station was far more luxuriant and vigorous in appearance than the grass elsewhere. This led him to make experiments in his own garden. He heated the soil electrically by means of buried lead-covered cables enclosing high resistance wire circuits. The success attained has made the system a commercial one. In Norway alone there are about 200 nurseries which make use of this method. In Great Britain there are two installations, one at the Cheshunt Horticultural Research Station and the other on the farm of Mr. Borlase Matthews at East Grinstead. It is not necessary to maintain a constant supply of energy, as at 75 deg. Fah., the standard temperature, the soil retains its heat for a long period. Arrangements can therefore be made with the electric supply authorities, who can supply energy cheaply at certain hours of the day. Much less labour is required when the soil is heated electrically, and the plants are as healthy and strong as when the best manure hotbed is employed. In Sweden the method has been tested on a large scale. The standard electric beds are 92ft. long and the cables are enclosed in earthenware ducts to prevent them being damaged by the gardener's spade. Strawberries have been raised to maturity in two months by this means. Potatoes planted in April were ready for digging at the end of June, two months before the ordinary crop. The commercial results obtained have proved satisfactory.

Miscellanea.

A ROADWAY is to be constructed across the Quebec Bridge, at a cost of 350,000 dollars.

IT is estimated that the Cauveri-Mettur Dam scheme in India will cost 737 lakhs of rupees.

A SINGLE-DECK tramcar, 75ft. long, capable of seating 117 passengers, has been put in service in Dresden.

A BRIDGE is to be built across the St. Clair River to connect Sarnia, Ontario, with Port Huron. The cost is to be 4,000,000 dollars.

THE Greenhow lead mines, North-West Yorkshire, which have been idle for many years, are now again being worked with success.

A PLANT for the treatment of coal by the Illingworth process is to be set up at the Snowdon Colliery, Kent. It is to have a capacity of 400 tons a day.

IT is proposed by the Gas Referees that in future every gasworks making more than 2000 million cubic feet of gas per year must be equipped with a continuously recording calorimeter.

NATURAL gas coming from boreholes in Alberta is to be exported across the international boundary to Great Falls by a new pipe line. The supply is to amount to 10,000,000 cubic feet a day.

ARRANGEMENTS are being made for the air drying of the peat used for making briquettes at the experimental plant at Alfred, Ontario, and it is hoped that this step will make the factory a commercial success.

THE Mines Department announces that the Prime Minister has agreed to perform the formal opening ceremony on October 11th of the new laboratories which have been built at Sheffield for the Safety in Mines Research Board. This new research station will be the country's chief centre for scientific experiment for making coal-mining a safer occupation. Commodore H. Douglas King, Secretary for Mines, will preside at the ceremony.

AMERICAN industrial conditions are generally believed to be better than our own, but it is of interest to note that the *Electrical World*, in attempting to discover "what is the matter with business," concludes that the producing capacity of American industry has outgrown the present demand for the finished product. The solution is believed to lie, in part, in recognising a curtailed production as an acceptable thing, and raising prices to a profitable basis.

THE Swiss Electricity Inspection Department has recently issued its report on the accidents which occurred in connection with electricity supply—excluding electric tramways and railways—in Switzerland during 1926. It shows that 21 persons were injured and five killed in connection with installations at pressures up to 250 volts, as against 16 and five respectively in 1925. In connection with installations at over 250 volts, 32 were injured and 19 killed, as compared with 32 and 13 respectively for the preceding year.

A PULP and paper mill is to be put up at Dalhousie, New Brunswick, at a cost of 15,000,000 dollars. It is to have a primary capacity of 500 tons a day, but may be extended to turn out 750 tons. The contract calls for a group of main buildings consisting of the paper mill, groundwood mill, sulphite mill, power plant and slasher mill, and, in addition, two railway sidings about 2 miles in length, conveyor system, log stackers, 1200ft. stone breakwater, dredging, &c. The site of the mill is to be filled in by material dredged from the river.

EXTENSIVE exploratory work for antimony is being carried on at West Gore, Hants County, Nova Scotia. The area being worked for antimony is not a new one, as in 1915 683 tons of ore was mined at the West Gore workings. Antimony is a very valuable metal, worth approximately 250 dollars per ton. What makes the present workings still more valuable is the fact that the ore contains valuable deposits of gold. From the 683 tons of ore mined in 1915 there was obtained 1700 oz. of gold. Since 1905 4959 tons of ore were taken from the workings, containing in all 6955 oz. of gold.

THE Oldham Electricity Committee has obtained sanction to borrow £78,872, in connection with a new generating station. The building and civil engineering works are to cost £12,403; plant, £32,569; and cooling towers, £33,900. The South-East Lancashire Electricity Advisory Board is recommended by the Engineering Advisory Committee to support the Corporation's application for a Fringe Order in respect of property in Limehurst rural district. An alternative method of charging domestic consumers according to the rateable value of their premises will be brought into operation on September 25th.

A NEW tunnel, 20 miles long, for supplying New York with water, is to be driven from Hill View Reservoir in Yonkers, under the Bronx River and the East River at Rikers Island to the Borough of Queens on Long Island, thence under Newtown Creek to a connection with City Tunnel No. 1 in Brooklyn, and thence about 1·3 mile to Hamilton-avenue, in Brooklyn. The tunnel is to be driven from nineteen shafts of depths varying from 380ft. to 780ft. The deepest shafts will be in the portion north of the East River. The East River crossing will be at depths varying from 560ft. to 615ft. The finished diameter of the greater portion of the tunnel will be 17ft., the maximum diameter will be 21ft., and the minimum 15ft. The total cost is estimated at about 67,000,000 dollars.

ACCORDING to the statistical report of the Swedish Telegraph Department for 1927, which has just been published, there were at the end of 1927 seven broadcasting stations belonging to the telegraph service, with an average yearly service of 2043 hours per station, and 24 smaller private relay stations. The big Motala Station was put into operation in the middle of 1927. The stations at Gothenburg and Malmö are to be enlarged to 10 kW, and will use their present wave lengths. The number of licences granted at the end of the year was 328,133, or 53·9 per 1000 inhabitants, as against 242,559 and 39·9 respectively at the end of 1926. Of these Stockholm took 56,931, or 90·5 per 1000 inhabitants (80·0 in 1926), Gothenburg 29,051, or 77·4 per 1000 (81·6), and Malmö 16,703, or 9·87 per 1000 (101·9).

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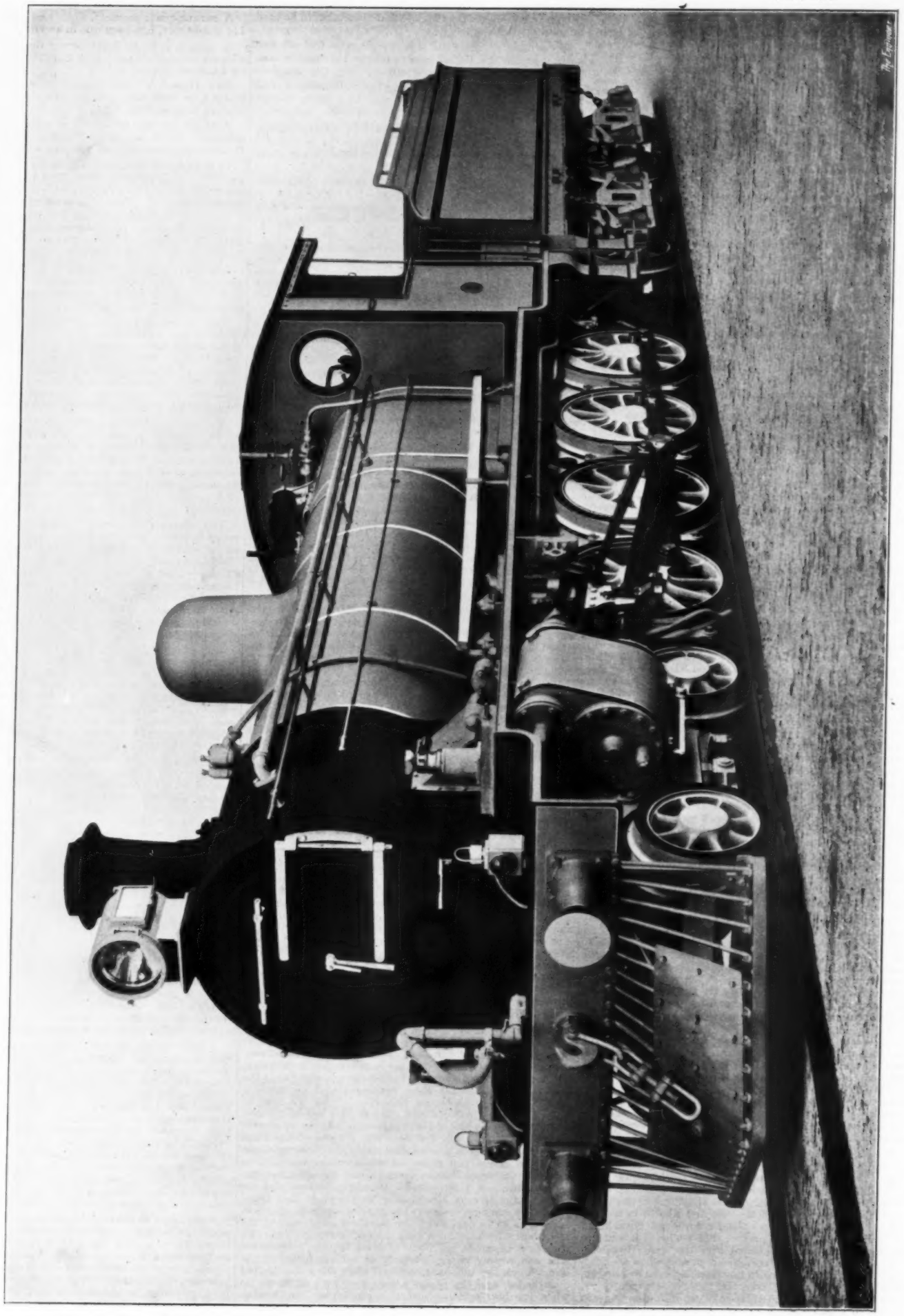
(For description see page 256)



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THE ENGINEER.

SEPTEMBER 7, 1928.

Railways and Road Transport.

WHILE the British railway companies are taking steps to meet the competition of road vehicles, it may be interesting to see in what way the same problem is being dealt with abroad. The competition is only felt seriously in those countries where the road systems are particularly good. The more money that is spent upon road improvements, the more difficult it becomes for the railway companies to keep what they regard as their proper share of the traffic. Anyone can ply for hire on the road and carry passengers and goods, and he has merely to provide the rolling stock without troubling himself about the way, for the use of which he pays nothing except the usual taxes. The only thing that keeps the motor vehicle within bounds is the axle load, which is determined by what the roads can stand without undue deterioration. If the roads were specially built to allow of vehicles with bigger axle loads running at fairly high speeds, the situation would obviously become still more serious for the railway companies. As it is, the restriction of loads limits the capacity for competition. All means of transport must be sufficiently flexible to deal with fluctuations of traffic, and it is doubtful whether a company running motor vehicles could afford to hold in reserve a sufficient number of them to double the traffic in case of emergency, while it is quite conceivable that the roads themselves would not carry, without serious deterioration, anything like the tonnage that would have to be delivered over the country during a period of exceptional activity. The congestion of traffic and the wear and tear of the roads would become insupportable. This was sufficiently demonstrated in France during the four years of hostilities. There is consequently a limit to the motor vehicle competition, which is, nevertheless, serious for the railway companies and threatens to produce a crisis unless it is promptly met.

The competition can be vanquished by an economical attack or by a method of assimilation, which is not the same as a monopoly. In this country competition is encouraged as a means of bringing the greatest good to the greatest number. Shareholders in railway companies are supposed to be a privileged class, their privilege being to make sacrifices for the welfare of the community, but in some countries abroad the losses of railway companies are made good, in one way or another, by the State, and consequently by the taxpayer. The methods by which the competition of road motor vehicles is to be met by the railway companies are therefore not the same in this country and abroad. Moreover, the conditions of competition are not the same. In Great Britain the railway system is highly developed, and is directly affected by what may be called a parallel road traffic ; while in France the area of the country is so much larger that the competition affects more particularly the local cross-country lines. Those lines are regarded as necessary for national defence, and therefore must be maintained. For years past it has become a problem of how to keep them running. It was hoped to save them by means of rail motors, but all chance of doing that has vanished with the popularity of road motor vehicles in country districts where the traffic is light. The main lines have suffered, but to a less extent, from the number of people who are carried to holiday resorts by motor cars and also by the increasing traffic of heavy motor vehicles. Road competition is growing, and the French railway companies propose to meet the situation by means which would seem to offer some chance of success. There is, first, the direct competition with motor traffic which is observable in the return to cheap holiday fares and in the running of motor car services for tourists in connection with the railways, but the companies do not intend to embark upon a deliberate policy of price cutting. That is a matter for the Conseil Supérieur des Chemins de Fer, which is more or less under the control of the Government. Although the French Government has withdrawn its guarantee for the payment of interest on railway debentures, it is, nevertheless, obliged to come to the assistance of the railways in cases of emergency. Therefore, the railway companies are assured of official support, and that places them in a strong position when determining a line of policy which will save them from the competition of road vehicles. There can be no claim to a monopoly of transport, for the French will accept no further monopolies, but there are always means of obtaining the same result by assimilation or amalgamation. This it is proposed to do under the new plan whereby a Société Auxiliaire des Transports will be formed in association with each railway company. The object of the Société Auxiliaire des Transports is to group all the transport services in territories through which passes the railway. It will reorganise transport and create new services where necessary, and the railway company will have a controlling voice in its management. There is no intention to sacrifice one service for another, but rather to utilise all the services as a means of increasing and co-ordinating traffic, which will be diverted naturally to the railways. This means that every remote country district, at present isolated from the railway system, will be brought into direct touch with it by a complete organisation of road motor traffic. The plan can only be adopted in a country like France where there are large agricultural territories with a particularly good network of railways.

The problem may also find another solution of more immediate interest to countries that do not possess roads good enough to favour motor traffic. Even where the competition of motor vehicles is not to be feared, it is possible to utilise motor transport to the advantage of the railways. As the railways in France are under the control of the Conseil Supérieur des Chemins de Fer, so technical problems involving departures from general practice are dealt with by a central organisation. That body investigates every new phase of traffic conditions. It has to deal with rail motors and it has for some time past been developing plans for more powerful machines, which are really locomotives with internal combustion engines. These, by the way, will be employed on the Trans-saharan railway if ever it is constructed. On the home railway systems other ideas are being elaborated which may possibly change completely railway methods in the more or less distant future. Except where the railways are electrified, the steam locomotive will not lose its supremacy, but much more flexibility will be given to the service if experiments now being carried out should justify the adoption of a system for employing motor vehicles, both on the road and rail. In France the roads are generally wide, with borders on which it is possible to lay down tracks, and a type of motor vehicle with rubber tires has therefore been designed for running on metal or concrete tracks, on the side

of which there is a guiding rail with grooved roller to keep the vehicle on the track. When single vehicles are running they will be steered in the usual way, and the guiding rail will be employed when a train of motor cars is employed. On the railways it is proposed to install a similar guiding rail so that the vehicle can be changed from the road to the rail. The idea of this arrangement is to allow of light loads being collected at any point of the territory, and of being carried at high speeds over long distances. Nevertheless, the system is not intended primarily for the home railways, and is being experimented with more particularly for the colonies, where it is believed that the motor vehicles will serve as economical feeders to the railways. What is being done on the Continent shows clearly enough that the problem of motor road transport is being solved in the direction of assimilating all methods of traffic with the railways, without, however, monopolising interests. This course is held to ensure efficiency, with better service to the public.

Gas Producers for Boiler Furnaces.

CONSIDERABLE interest is being taken on the Continent in the use of gas producers in connection with boiler furnaces, and several important installations are now in operation. The principle does not consist, as might be imagined, in gasifying the fuel in a producer and burning the gas so generated in the furnace, but lies rather in the use of a producer as an adjunct to the ordinary mechanical stoker. The producer, in a typical case, takes the place of the usual ash hopper and receives the ashes and clinker continuously as they fall from the end of the grates. The contents of the producer rest on a pair of crushing rolls, by the slow rotation of which they are continually discharged into an air-tight hopper which is emptied at intervals. The hopper is maintained under a fairly considerable air pressure, the air together with a certain amount of water vapour passing upwards through the ashes and clinker in the producer and gasifying the last traces of combustible material. The gas burns at the producer top, where it meets the excess air which has passed through or over the grate, and its combustion contributes its quota of heat to that generated in the furnace proper. The producer body is unlined and is water jacketed so that a certain amount of the heat in the refuse may be usefully recovered. Apparatus of the type described, though comparatively novel, has already come into use on a sufficiently large scale to warrant its consideration by those who are concerned with improving the efficiency or facilitating the operation of boiler plant. In one power-house in Germany, for example, we have seen no less than twenty-four producers working in conjunction with forced draught chain-grate stokers. The results are said to be entirely satisfactory, maintenance costs being negligibly small and the losses from unburnt combustible in the ashes being reduced to a quite insignificant figure. Since the primary object in using a producer at all is to ensure that no burnable material passes away with the ashes, it may be said that this particular plant fulfils its purpose. But the question remains as to how far it is a superfluous safeguard. It is not uncommon, on a boiler test, for the heat lost in unburned combustible in the ashes to be returned as considerably less than 1 per cent. of the original heat value of the fuel. We have before us figures of 0·6, 0·4, and 0·9 per cent. for what we may call for brevity the "ash losses" on the official tests of three stoker-fired boilers in a London power station, the data from which can be absolutely relied on. That such figures can be maintained in ordinary service would be too much to expect. The Padiham station of the Lancashire Power Company does indeed keep its ash losses down to 0·65 per cent. of the original heat in the fuel, as a year's average, but Padiham is in a class by itself for efficiency. The corresponding figure for Dalmarnock was given some years ago as 2 per cent. On the other hand, we find ash losses running as high as 3 per cent. and over, even on official trials, so that there must be boiler-houses where in average working one would expect at least 5 per cent. of the heat of the coal to be lost by combustible material carried away in the ashes. This figure has indeed been given as representative of average boiler operation in the United States.

Although the percentage of the calorific value of the coal which is lost owing to unburnt material in the ashes is the true measure of the inefficiency of the furnace, the question of adding a gas producer to the plant is better judged in the light of the constitution of the furnace refuse. The heat loss, for example, would be practically identical in the case of two boilers, one giving refuse equal to 20 per cent. of the coal burnt with a combustible content of 10 per cent., and the other giving 12 per cent. of refuse with a combustible content of 16·7 per cent. It is evident that the latter case would be much more favourable to the producer, for not only would its fuel be richer, but there would be much less refuse to be dealt with. The question turns, therefore, rather on the percentage of combustible in the ashes than on the heat loss attributable to this combustible, provided always that the heat loss is sufficient to justify special apparatus for its recovery. The percentage of combustible can only be obtained by analysis, any deduction from the weight of the refuse in proportion to the ash content of the original coal being vitiated by the fact that an unknown quantity of ash is always carried away by the chimney gases. Suppose that this combustible amounts to 20 per cent. of the furnace refuse, which is a figure well below the proportion sometimes found, we have to consider not only what the corresponding heat loss amounts to, but to what it could be reduced by passing the refuse through a producer. Unfortunately, the greater the slagging qualities of the fuel, the higher the waste of combustible is likely to be. Hence, although the refuse might be rich enough in carbon to make gasification appear worth while, the combustible might be so incorporated with the slag that it would pass through the producer practically unaffected. In such an event, of course, the producer would be worthless. Producer plant has been used in France to gasify colliery refuse containing as little as 35 per cent. of combustible, but even then a small amount of coke breeze was added. Moreover, in this case the apparatus was really rather a blast-furnace than a producer, the slag being run off in a liquid form. Such a process has little to do with boiler practice, at any rate for the present. For a producer to gasify furnace refuse under conditions tolerable in a boiler-house, it would seem either that the refuse should be fairly free from slag or that the clinkers should be sufficiently porous and friable for all combustible material to be exposed directly to the air and water vapour supplied for gasification. It may be that it would pay to run the grates faster and with thicker fires, thus deliberately sending over a lot of incompletely burnt fuel in order to make the conditions better for the producer. The limit of development in this direction would be to do without grates at all and completely gasify the whole of the fuel. The primary objection to such a process lies in the want of flexibility in a producer. The latter cannot be made to respond, to anything like the same degree as a mechanical stoker, to rapid changes in the demands for steam. The more, therefore, the producer encroaches on the functions of the stoker the less handy does the whole boiler plant become. Again, there is always the question whether a producer, even working under favourable conditions, can deliver refuse substantially freer from combustible matter than that coming from a well-operated mechanical stoker. If it cannot, and there is little evidence to show that it can, then there is little left of the case for the producer. It saves nothing on the score of space, for the fuel burnt per square foot of area per hour is less than that common with stokers. The output of gas cannot be increased greatly by an increase in the supply of air or steam, because, if forcing is attempted, CO_2 is formed in place of combustible gas. The only remaining point is whether a producer will or can recover from the refuse delivered by an ordinarily operated stoker sufficient heat to make its installation worth while. There are, as we have said, certain engineers of standing on the Continent who think that it can, but a contrary opinion is at least tenable.

We have confined our discussion to the provision of producers to deal with the ashes leaving the end of mechanical stokers because, so far as we are aware, their use has been confined to this duty. But if there is a case for them at all, it would seem to be much more attractive if they could be installed in such a manner as to deal more completely with the delinquencies of the ordinary stoker. The riddlings, for example, which fall from travelling grates are far too rich in combustible to be thrown away, so that they either have to be scraped out of the ashpits and thrown back into the stoker hoppers by hand or collected in separate riddling hoppers and returned mechanically to the coal bunkers. All this involves labour and necessitates troublesome corrections to the records of the automatic coal weighers or Lea meters if an accurate account of the fuel burnt is to be kept. Furthermore, when the riddlings find themselves once more on the grate there is no reason why they should not fall through again. A large proportion of them, in fact, will do so, and the cycle of returning them has to be repeated. Besides the riddlings there is the flue dust, which is very highly carbonaceous when small fuel is burnt with forced draught. This collects in quantity wherever it can and has to be periodically cleaned out and thrown away. If riddlings and flue dust could be shot into the producer with no trouble the advocates of producers would have a much stronger argument. The ultimate boiler refuse, as completely decarbonised as possible, could then fall continuously from the bottom of the producer through a submerged shoot into a water trough and be disposed of simply and satisfactorily. Such a plant could be almost automatic and could no doubt be accommodated in boiler-house basements of the usual height. But intelligent supervision would be just as necessary to the producer as it is to the operation of a stoker. The air supplied, under pressure, be it remembered, must be regulated reasonably in accordance with the producer requirements, since too little would result in ungasified fuel, while too much would reduce the flue gas temperature and give rise to all the inefficiency and trouble caused by excess air entering the furnace in any other way. Obviously, too, the depth of material in the producer at any time must be neither too great nor too little, or the variation in the resistance of the fuel bed would interfere with proper working.

The Institute of Metals.

No. I.

ANNUAL MEETING AT LIVERPOOL.

THE Autumn Meeting of the Institute of Metals was held this year at Liverpool from September 4th to 7th, under the presidency of Dr. Walter Rosenhain, F.R.S.

NON-FERROUS METALS IN THE SHIPPING INDUSTRY.

The proceedings opened on Tuesday evening, September 4th, with the delivery of the seventh Autumn Lecture in the Arts Theatre at the University. The lecturer was Mr. F. G. Martin, B.Sc., F.I.C., whose subject was "Non-ferrous Metals in the Shipping Industry."

Mr. Martin opened his remarks with a reference to the great extension of the range of non-ferrous metals called into service in the shipping industry to-day—although the main interest still centres about steel and iron—and pointed out that there are hardly any of the commercial metals or their alloys which do not play some part in the construction of the modern ship and its engines. Even the precious metals, such as gold, platinum, and silver, have their uses—small, it is true—but it is interesting to note that one firm in the Mersey area used in one year no less than 20,000 oz. of silver in the construction of its engines.

It is not too much to say, he continued, that if it had not been for the metallurgist, and largely for the non-ferrous metallurgist, the modern engine would not have reached its present high perfection, or it would have been attained at much greater expense. One can almost trace the development of engineering side by side with that of scientific metallurgy—one might almost say with the birth and development of the Institute of Metals. At times new discoveries in metallurgy have been followed by their adoption by the engineer; at others the engineer has called for metals or alloys to meet special contingencies, and, as a rule, the metallurgist has supplied the want. Occasionally, the engineer calls for the impossible, and then the metallurgists are spoken to unkindly, and made to feel that they have no right to a place on the earth.

Viewed from a shipping angle, the non-ferrous metallurgist normally has three enemies—(1) himself; (2) sea water, and (3) fuel oil. As regards the first, he has been known on occasions to look back after putting his hand to the plough. As to the second, Mr. Martin expressed the firm belief, as the result of many years' experience of ships, that, given plenty of it, and for long enough, the most powerful corrosive agent on the face of the earth is sea water. Hydrochloric acid, nitric acid, sulphuric acid, &c., pale before it. As to the third point, he said that the increasing use of fuel oil, whether in the internal combustion engine or whether burned in boilers to raise steam, has brought with it quite a number of troubles, many of which have yet to be solved.

One of the greatest difficulties introduced by the use of fuel oil—*i.e.*, its deteriorating action on electric cables—has now been successfully overcome. The ordinary electric cable as supplied to ships consists, first, of an internal core of copper, surrounded by rubber as an insulating medium, but, in order to protect the copper from the action of the fillers—including sulphur—in the rubber, the copper strands composing the inner core have to be tinned. Outside the rubber insulation there are layers of lead and braid, and, finally, steel wire. Such a structure does not lend itself to acute turns round corners and over frames. It does not stand the test of age, and,

worst of all, it rapidly deteriorates under the influence of fuel oil. A successful solution of the difficulty has been reached by two Liverpool men, in the substitution of a cellulose product for the rubber, thus eliminating the necessity for tinning the copper and for using lead sheathing. The resultant cable is much more flexible, can be turned back on itself without fracture, and, above everything, is particularly resistant to the action of fuel coil; indeed, prolonged immersion in fuel oil appears, if anything, to increase its efficiency.

In shipping, the problems of wear and corrosion assume relatively enormous proportions, continued Mr. Martin, and it is often on this account that non-ferrous metals and their alloys have replaced iron and steel. The classic instance is that of the propeller, which was generally of cast iron or steel in the earlier steamship days. Such, however, was the damage through corrosion and erosion that the experimental substitution of brass for iron took place at an early stage with most gratifying results, speed as well as durability being markedly increased. Since that time the brass propeller has become practically universal, such further improvements as have been introduced being those of detail rather than of type. Here was simply the replacement of a material which could not stand up to working conditions by one which could; but even here a considerable amount of metallurgical knowledge was involved. Cast iron had considerable strength, but was very brittle under certain conditions; it had great hardness, medium specific gravity, and great corrodibility. What was wanted—and what was very quickly forthcoming—was a material having, again, considerable strength, a specific gravity not too far removed from that of iron, little or no corrodibility, and sufficient hardness to withstand erosion, without the presence in excessive amounts of any brittle constituent, such as occurs in low-grade cast iron. What is desired in the case of a propeller metal is that it be stiff, in the sense that it will not whip, but it must not be so stiff that if it should hit submerged wreckage it will snap off short like a carrot. At the same time, it must be sufficiently ductile to yield to a certain extent to contact with undesirable and misplaced solids, but not ductile enough to bend sufficiently to foul its own rudder. So that a compromise between the two has to be found, and this can best be achieved by the use of a mixture with mechanical properties very roughly as follows:—

Mercantile Marine Propeller Metal.

	Approximate composition. Per cent.	Typical analysis. Per cent.
Copper	59–60	59·64
Zinc	35–37	36·15
Iron	1	0·91
Manganese	1–2	1·56
Aluminium	2	1·74
		100·00

Mechanical Tests.

Ultimate strength	33 tons per sq. in.
Elongation in 2in.	28 per cent.

A slightly stiffer blade, with rather less elongation, can be obtained as follows:—

Admiralty Propeller Metal.

	Approximate composition. Per cent.	Typical analysis. Per cent.
Copper	56–57	55·62
Zinc	40–41	41·90
Tin	1	1·08
Iron	1	0·91
Manganese	0·25–0·5	0·25
Aluminium	0·25	0·24
		100·00

Mechanical Tests

Ultimate strength	36 tons per sq. in.
Elongation in 2in.	25 per cent.

It is obvious, said Mr. Martin, that the previous type of brass most suitable for use in this capacity must have formed the basis for a great deal of research, and even at the present time investigation is constantly being directed to such modifications of the original 60/40 brass as seem likely to increase any desirable quality of propeller metal without unduly detracting from the rest. The general tendency appears to be to increase hardness and toughness by the addition of small amounts of such metals as manganese and nickel, which do not form a separate hard constituent, rather than such hardening agents as tin and iron, which frequently do. Further, the study and control of casting conditions, by the increasingly close co-operation of foundry and laboratory, have largely eliminated from propeller metals such defects as porosity and oxide films, and have gone far to ensure a strong and finely grained structure rather than a coarse and brittle one. Hence we have in the propeller a problem which may be regarded as practically solved.

Special types of the bronzes are gun-metals, and these find much application in a ship for liner work. Gun-metal—copper, 88 per cent.; tin, 10 per cent.; zinc, 2 per cent.—is the most usual material for this purpose. In the making of gun-metal castings, said the lecturer, we have an instance of tried and most welcome practical help from the metallurgist to both brassfounder and engineer, in a paper published in 1917 in the *Journal* of the Institute by Dr. Carpenter and Miss Elam, and generally recognised as part of the fundamentally important literature on the subject. In it are investigated and clearly described the correct conditions for casting gun-metal and the defects likely to occur through faulty materials or wrong practice. Mr. Martin described the whole paper as an outstanding example of direct help with practical problems which is the result of careful laboratory research combined with a thorough grasp of practical considerations.

Emphasising the very serious results which may often accrue through neglect of proper casting conditions, even in metal of normal composition, he instanced a certain gun-metal liner. It had appeared sound until machining was in progress, but complaints were then made of extreme local hardness, where the tool made little or no impression, but which showed great brittleness under shock, hard fragments tending to become detached and cause defects elsewhere. Examination showed that the hard spots were caused by the presence locally of a very high percentage of tin. Analysis indicated that the composition of the liner was normal, and that it was the distribution of the constituents which were at fault. Casting conditions were, therefore, probably to blame for the segregation of the hard constituent, and it was established that owing to excessive heating the material had actually cooled very slowly through the interval of temperature during which the δ constituent makes its appearance, thus giving time for it to form large and dangerous masses instead of appearing finely divided and evenly distributed.

For making smaller castings, such as pump fittings, gun-metal is again very popular; its small corrodibility, its stability at comparatively high temperatures, and its resistance to wear, make it very suitable for work of this type. A harder alloy, with an increased tin percentage, and therefore showing a higher proportion of the hard δ constituent, is in use for worm gearings and in other fittings where the wear is very severe. Defects are sometimes met with in this class of material, on account of the loose commercial application of the name "gun-metal," which, in some quarters, is regarded as covering bronzes with almost any percentage of tin and zinc. The hard type of bronze required for worm gearing has a considerably lower melting point than ordinary gun-metal, and consequently requires different and carefully regulated casting conditions. If these are not arranged for, the castings are liable to most of the ills gun-metal is heir to, in an intensified form.

Dealing with the question of white metals, or bearing metals, Mr. Martin said it is almost universally agreed that a bearing metal should consist of relatively hard particles embedded in a softer matrix—the latter minimising the effect of vibration and shock, while the hard wear is taken by the former. It is further believed very generally that the process of lubrication involves some interaction between the oil and the material of the bearing. Beyond this point there are widely differing opinions on the mechanism of the process, and the actual part played in it by the different constituents of the alloy.

The most generally satisfactory type for marine work is a tin base alloy containing antimony and copper, of the composition tin 86 per cent., antimony 9 per cent., and copper 5 per cent. This has a reasonably soft matrix, containing two types of hard constituent—the cubical crystals of the tin-antimony compound and the needle-shaped copper-tin crystals. The latter are the first to solidify from the molten state, and by then forming a solid network they keep the grain fine and the distribution of the other constituents even, given proper casting conditions. If conditions are improperly controlled, the harder portions become segregated. Fusion begins in this material at about 238 deg. Cent. In cases where lubrication has been careless, or from any cause has failed, one may even get evidence of local fusion and re-crystallisation.

The general experience in marine work would emphatically discourage the use of the more fusible bearing metals, especially those of the lead-base type. An analysis of a lead-base bearing metal was given as tin 8–9 per cent., antimony 16–17 per cent., copper a trace, lead 74–75 per cent. Fusion in this material, where lead and tin are both present in quantity, begins rather above 182 deg. Cent., but the alloy is in any case dangerously soft much below this temperature.

A lead-antimony bearing metal was next referred to, the analysis being tin a trace, antimony 21·2 per cent., copper 1·4 per cent., iron 0·04 per cent., nickel 3·8 per cent., zinc a trace, lead 73·6 per cent. The eutectic of lead and antimony, while less fusible than that of lead and tin, is still unduly soft for heavy work, the solid solution of nickel in copper being actually the hardest component present in any appreciable quantity. Such an alloy is scarcely hard enough for heavy duty in the main bearing of a marine engine, though for smaller bearings it might prove more suitable. In view, however, of the conditions under which marine bearings work, and in which they must sometimes be fitted, the "plastic bronzes" and other alloys of the harder and less fusible type are unsuited for this work. Mr. Martin stressed the importance of the closest co-operation of the metallurgist and the engineer in problems such as this, and pointed out that the more careful the latter's observations and records, the easier will be the task of the metallurgist, and ultimately, in consequence, the engineer's. In this department, he added, record keeping is not on the same high level as in the case of fuel consumption or condenser practice; the point of making such records is, of course, less immediately obvious than in the other instances, but so much remains to be learned about both wear and lubrication that such notes could not fail to be of great service.

It must also be borne in mind that the question of cost has something to do with the selection of a white metal. At the present day the cost per ton of a lead-base white metal—86 per cent. lead—is £42, while the cost per ton of a tin-base white metal—86 per cent. tin—is £204.

Dealing next with materials for turbine blading, the lecturer said they still are, in spite of the attacks of stainless steel, almost entirely non-ferrous. They include such diversified items as 96/4 cupro-manganese, and Monel metal for high-pressure stages, and brasses, including 70/30, for intermediate stages and low-pressure ends. The failure of blading, in his experience, is only rarely to be attributed to faulty material, *i.e.*, to material which is either intrinsically unsuitable or which has been worked up from unsound ingots, or has been improperly treated either mechanically or from the temperature point of view. The constructional difficulties, together with those introduced by the erosive and corrosive action of steam and water, have been very largely overcome, and marine engineers responsible for construction, no less than the inventors of the different turbines, are to be congratulated on the successful service obtained in this field from the non-ferrous metals.

Condenser corrosion was then discussed. The marine condenser brings us face to face with widely and frequently varying conditions of wear, and perhaps nowhere else does the metallurgist come into more direct conflict with the engineer. Between the two experts there prevails a state of acute criticism, which is not only healthy, but desirable. In stressing the vital necessity of co-operation, Mr. Martin urged that it must come not only from the metallurgist and the engineer, but from the owner also. The working conditions in the marine condenser are extraordinarily difficult, either to isolate or reproduce; therefore, tests must be carried out on an actual run, and he expressed gratification that frequently the owners gave facilities for such tests, with highly instructive results. At the same time, he pointed out that these latter tests are merely the coping stone or the lid on years of previous research.

Examining some of the methods of dealing with the condenser problem, he said that the first is to concentrate on design. In this connection he referred to a valuable system of observation in use in many ships, whereby the position of each unsatisfactory tube, and of the points on the tube where failure occurred, are regularly recorded on standard plans. When sufficient records of this type are available, he said, they may supply information of great value.

Dealing with the various materials used for condenser tubes, he referred first to the 70/30 brass, and to the subsequent evolution of the copper-nickel alloys. The latter have been, at least, partially successful, but apparently the degree of success is intimately associated with the concentration of nickel, and with increase in concentration of nickel there comes increase in difficulty of working, which is keeping the tube maker very busy trying to reconcile his costs with his selling price. Doubtless in time the metallurgist will come out on top, and these alloys will take the place they deserve. In the meantime, the seriousness of the corrosion problem has driven the marine engineer to seek relief in other directions, such as the coating of the insides of tubes with such substances as bitumastic; but, while considerable relief was given thereby to the corrosion evil, there was marked loss of heat conductivity. Pure nickel tubes are now in use, and the production of nickel has made such rapid strides of late that its increasing possibilities must be of the first importance. Mr. Martin instanced this as another example of the metallurgist having shown the way to new commercial uses and cheaper production.

Various attempts have been made to use the standard type of brass tube, but to render it incorrodible by the deposition of a thin impenetrable layer on its inner surface. The latest attempt, he believed, to fight the corrosion disease has been by the deposition of metallic chromium on the inside or sea-water side of the condenser tube. This method has presented its difficulties, but apparently the metallurgist has overcome them, and a tube plated in this way is now on the market. It also has the advantage of possessing at the normal temperatures of condensers and at the normal water speed of about 5ft. or 6ft. per second, a marked increase in conductivity for heat, of the order of 20 per cent.

THE old railway bridge spanning the gorge at Blaawkrantz, on the line from Alicedale to Port Alfred, South Africa, has recently been replaced by a new structure, at a cost of £29,000. The new bridge has been erected on the same site as the old, the one structure being interlaced with the other, without interrupting traffic, and the old bridge will now be cut up and removed. The former structure was built in the 'eighties, and was only designed for light traffic. The task of building the new structure was no easy one, as the rail level is 185ft. above the bottom of the gorge.

THE DIESEL-ELECTRICALLY PROPELLED OIL TANKER BRUNSWICK

SCOTT'S SHIPBUILDING AND ENGINEERING COMPANY, LTD., GREENOCK, BUILDERS

The Diesel-Electric Oil Tanker Brunswick.

No. I.

IN a Journal note which appeared in our last issue we made brief mention of the successful trials of the Diesel-electric oil tanker "Brunswick," which took place on the Clyde on Wednesday, August 29th. The new tanker, which has been constructed by Scotts' Shipbuilding and Engineering Company, Ltd., at Greenock, to the order of the Atlantic Refining Company, of Philadelphia, has aroused keen interest in marine engineering circles on account of the many new features which her design embodies. She bears the distinction of being the largest Diesel-electric propelled vessel afloat. It is interesting to learn that owing to the use of standardised land type non-reversible oil engines and standard electrical equipment, together with the smaller auxiliaries required, the whole cost of the machinery equipment was not more than that of a direct-driven motor tanker designed to carry the same amount of cargo.

With the permission of Mr. Lester M. Goldsmith, the consulting engineer to the Atlantic Refining Company, we are now enabled to give some further details of this interesting vessel and her performance.

The tanker "Brunswick" is the ninth electrically propelled vessel to be added to her owners' fleet, and she embodies the sea-going experience obtained with the other ships. Her main particulars are given below :—

Length between perpendiculars	469ft.
Beam	63ft.
Draught	26ft. 6in.
Moulded depth	36ft. 9in.
Deadweight, about	13,200 tons
Gross tonnage	8947 tons
Designed speed	11 knots

As the illustration above shows, the bridge and accommodation is placed right aft, so that both the navigating and machinery *personnel* is concentrated at one part of the ship. The vessel is framed on the longitudinal system and the erections consist of a top-gallant forecastle for cargo and stores, a long poop for housing the crew, and houses above the poop for the officers and for navigation. The accommodation is of the highest order, rooms being provided for every two of the crew. Effective steam-heating arrangements have been installed to suit the extremes of temperature met with in service.

The absence of the usual funnel will be also noticed, the only uptakes being that of the auxiliary heating boiler, and the four exhaust pipes and silencing heads for the generator engines. There are ten pairs of main and summer tanks, and these, with all the piping connected with them, have been specially arranged for the carriage of light oils.

A distinctive feature of the hull equipment is the installation of the Sperry gyro compass and gyro pilot, and electrically controlled winches, windlass and pumping gear.

The lines of the ship and her propeller were tested at the Hamburg Tank. We are able to state that the actual performance of the ship on trial when checked with the test tank data, varied from the predicted performance by less than 2 per cent. Special value is attached by the owners to this close agreement, in view of the fact that in an electrically propelled ship such as we are describing, the shaft horse-power is measured in the most accurate way known. It is possible, they suggest, that where discrepancies have been noted in the past, they were more likely to be due to "errors" in measuring the shaft horse-power than the actual data obtained in the tank test. The maximum speed attained on the Skelmorlie measured mile was 11·48 knots, or nearly half a knot more than the designed speed.

PROPELLING MACHINERY.

The ship is propelled by a single-screw motor of 2800 S.H.P., to which power is supplied by four 750 B.H.P., 225 r.p.m., Ingersoll-Rand type, four-stroke engines, working on the airless injection principle, with a bore of 19½in. and a stroke of 24in., built by Carels Fréres, of Ghent, Belgium. Each of these engines—see Fig. 1—is coupled direct to a 600-kW, 250 v. direct-current propelling generator, and to a 75-kW auxiliary generator of the same voltage, arranged in tandem, which supplies power to the ship's auxiliaries and excites the fields of the main generators and the propelling motor. The motor generators and all electrical equipment were supplied by the British Thomson-Houston Company, Ltd., of Rugby.

It may be noted from the figures given above that the rated horse-power of the main propelling motor and the kilowatt capacity of the generators do not agree with the rated brake horse-power of the engines driving the generators. These powers, however, have, we are informed, been specially decided upon by the owners in view of possible further developments which they have in view.

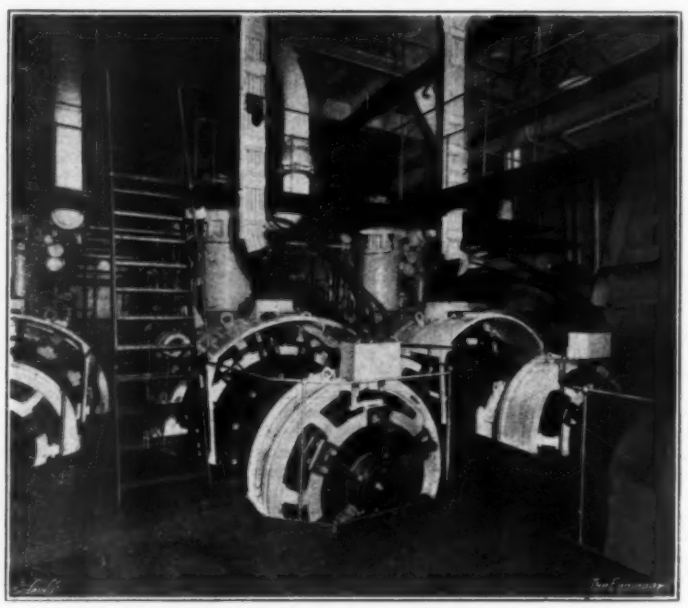


FIG. 1—MAIN GENERATOR AND EXCITER SETS

FIG. 2—THE MAIN PROPELLING MOTOR

Fig. 2 is a view of the main propelling motor, which was taken looking aft from the top of the engine platform of the generator sets. The motor is built up of two units—each with a separate magnet frame, armature, and commutator—which are mounted on a common shaft and supported between two pedestal bearings. The bearings, like the outboard bearings of the four generator sets, are all of the disc type, with wiper lubricators.

As the propelling motor is really two motors connected in series it is possible, when only using one-half of the motor, to develop sufficient power for three-quarter speed. The combined voltage of the four generators may be 1000, 750, 500 or 250, according as four, three, two or a single generator set is in the propelling circuit. By varying or reversing the excitation in the main generators, it is possible to start, stop and reverse the main propelling motor.

At this point we may digress to remark on the very spacious engine-room and the pleasing and clean

appearance of the machinery, which is finished in a cream enamel, other appropriate colours being employed in order to distinguish between the various pipe circuits.

ELECTRICAL CONTROLS AND EQUIPMENT.

The electrical control arrangements are so designed that both the speed of the ship and its direction of propulsion are directly controlled from the bridge by the officer on watch. This is done by means of a special attachment constructed by the British Thomson-Houston Company, which is combined with the Sperry gyro-pilot. In Fig. 3 we give a view of the control pillar on the bridge, looking in a forward direction. The two side levers move over dials which are marked "Ahead," "Stop," and "Astern," and by setting these levers in appropriate positions the desired speeds can be obtained in either an "ahead" or "astern" direction, or the motor can be brought to a standstill. On the forward bulkhead, immediately in front of the control pillar, there are three instruments which register clearly the volts and amperes in circuit and the speed and direction of the propelling motor.

The small hand wheel behind the pillar is for hand steering, while the vertical lever to the left of the pillar serves to link up either hand or automatic gyro steering, as may be desired. At other parts of the control room there are fixed the automatic course-recording instruments, and an indicator which shows the movement of the rudder at any given instant.

Another feature of the control circuit design is that no main propelling circuits are ever interrupted, the

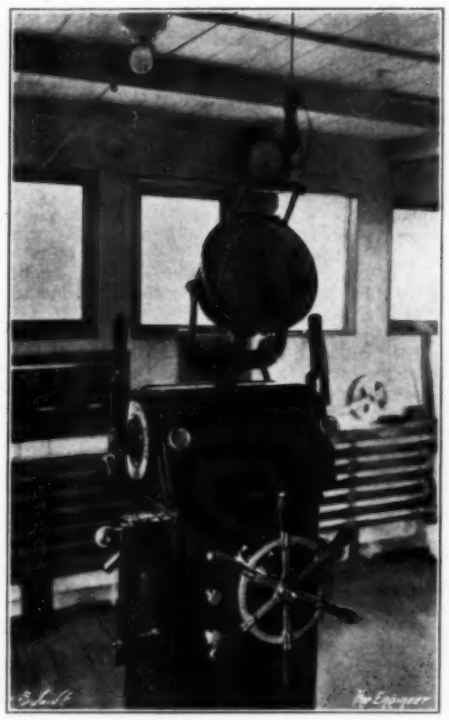


FIG. 3—BRIDGE CONTROL PILLAR

speed and direction of rotation of the motor being determined entirely by regulation of the field current. During manœuvring operations the field circuits of the four generator sets are varied in strength by a reversing potentiometer rheostat, motor-operated through gearing. The motor, which has been specially built to the owner's specification, is designed to apply the voltage to the main propelling motor in such a manner that a true cube speed curve is closely followed. Were the motor to be of the constant-speed type, then overloading would undoubtedly take place. Any movement of the lever on the bridge control pillar merely switches the small motor into circuit, and by means of follow-up gear, the motor switches itself out again and stops as soon as it has moved the field rheostat into such a position that a field strength is obtained on the generator corresponding to the speed point at which the lever on the controller has been brought to rest.

A further useful provision is the fitting in the main circuit of a special type of overload current relay, so that should the operator accelerate or decelerate too quickly and so cause excessive power current to flow in the circuit, then the current in the rheostat motor is temporarily interrupted. With such an arrangement, although the bridge control lever may be operated very quickly, the varying of the generator field strength is only carried out when the relay again completes the supply circuit to the rheostat motor. In this way the captain is able to carry out orders in the quickest manner possible, but the equipment is safeguarded against careless handling.

There are no circuit breakers or other power interrupting devices in the main propelling circuit, the handling of the equipment under abnormal conditions being entrusted to the engineer on watch. It is not possible to overload the motor for any length of time, as its size is equal to the capacity of the generating plant. In order to give warning should an earth take place, a connection to the ship's structure is made through a circuit breaker, and a current-limiting resistance at a point between the armatures of the two motors. In case of an earth occurring of sufficient magnitude to operate the circuit breaker, a bell is rung in the engine-room to give warning. Arrangements are provided so that the engineer on watch can put in or take out a generating set from the propelling current or by means of a lever transfer the excitation from one auxiliary generator to another without leaving his post on the switchboard gallery. This was demonstrated during the trial, when one generator set was used to operate the cargo pumps, so that the speed of the vessel could be tested at two different displacements.

Should excitation voltage fail, the main potentiometer rheostat is arranged to return to the "stop" position, re-closing the field contactors, resetting the overload relay if this has been tripped, and returning to the previous setting, determined by the bridge controller, as soon as the voltage supply is resumed. Emergency hand control arrangements are provided, whereby the rheostat can be operated by a hand wheel, should the motor driving the rheostat potentiometer fail. The motor operating the bridge control will complete a full power reversal in about 8 seconds, but the hand gear on the meter panel is designed to make the same reversal in about 30 seconds.

When bringing the propeller to rest prior to a reversal in its direction of rotation, the power returned to the electrical system is dissipated by motoring the propelling generators.

(To be continued.)

SIXTY YEARS AGO.

MONSTER station roofs engaged our attention in a leading article in our issue of September 4th, 1868. The "gigantic rotundity" of St. Pancras Station was then fast advancing towards completion. Charing Cross and Cannon-street Stations had not long been finished, and were conspicuous for the monotonous hardness of outline of their huge arched roofs. We sought to argue that such huge structures were uneconomical and unnecessary, and that the multi-span roof with its intermediate supporting columns was in every way to be preferred. The roof of Victoria Station and that of the Brighton Railway's station at London Bridge were, we contended, good examples combining all the requirements of a station roof with adequate accommodation. It had, we said, been clearly proved by costly experience that long span bridges were mistakes, and that the cost of a bridge increased in a much larger ratio than the mere increase of the span. A roof was nothing more than a bridge carrying a comparatively light static load, and the same considerations governed its economic construction. The presence of intermediate supports in a multi-span roof was not, we contended, a disadvantage as was frequently stated, but rather the reverse, for the pillars in the centres of the platforms served to form a discontinuous division dividing the traffic belonging to the train on one side from that of the train on the other. The subject, we stated, was of present interest because much station rebuilding work was likely to be done in London sooner or later. Waterloo Station, we believed, was to be reconstructed. It ought rather, we said, to be abolished as a terminus, and the trains arriving at it should be run on to Cannon-street and Charing Cross by a junction with the South-Eastern line at the back of the Waterloo terminus. It was time, too, that the dingy line of low sheds constituting the London and North-Western terminus was removed and replaced by a more modern specimen of roof construction. Fenchurch-street Station was bad beyond condemnation, and Shoreditch Station might be remodelled with benefit to every one, including the company owning it. The passage of time has brought about the reconstruction of Waterloo Station, the collapse of the Charing Cross arched roof and its replacement by a multi-span roof and the rebuilding in part of Euston Station. Strangely, however, opinion has swung completely round as regards the situation of Charing Cross Station. If present plans are carried out that station will be abolished and a new terminus constructed on a site close to Waterloo Station.

ARISING out of the agitation, particularly in Bavaria, raised by some recent accidents in Germany, Dr. Dorpmüller, the chief of the headquarters administration of the Reichsbahn, has issued a public statement on the subject, in which he explains the causes of the five accidents in question, all of which occurred between June 10th and July 21st. As the conditions mentioned are what has been experienced in this country at times, *e.g.*, in 1905, 1906 and 1915, it is instructive to read that Dr. Dorpmüller says, "On every railway, from time to time, a group of accidents attracts public attention and leads to extravagant assertions which find no justification in the annual returns. The Reichsbahn has just passed through such a period, but there is no cause for alarm as to the general safety of the system. Every precaution is taken which foresight and experience can suggest, and if individual accidents reveal some departure from perfection, it must be remembered, on the one hand, that human fallibility can never be entirely eliminated, and, on the other, that the German railways are still suffering from the effects of the war."

Craftsmanship and Science.*

By Professor Sir WILLIAM BRAGG, K.B.E., D.Sc., D.C.L., LL.D., F.R.S., President of the British Association.

WHEN, nearly a century ago, the founders of our Association drew up a statement of purposes and rules, they gave prominence to the words "to obtain more general attention for the objects of Science." In the last few years scientific inquiry has advanced at a rate which to all is amazing, and to some is even alarming. On the one hand, the application of science to industry has become increasingly important and obvious; on the other hand, in the less material realms the applications of recent research has aroused wide interest, as may be exemplified by the influence on philosophic thought of the new discoveries in physical science, or by the effect of last year's remarkable address from this chair.

In speaking of "craftsmanship and science," I propose to pay attention more particularly to the relations between science and the craftsmanship of our own country. The term craftsmanship requires definition. I am supposing it to mean the skill which is exercised in the production of whatever is wanted for human welfare. Imagine an island so cut off from the rest of the world that its inhabitants must depend on themselves for the satisfaction of all their desires, for their food, even if they have no more to do than pick fruit from a tree, for their clothing, for their housing, and other material things. They must also find their own means of satisfying less material cravings; for if they have intelligence they will look for means of studying themselves, their neighbours and the world round about them. What the islanders succeed in achieving by their craftsmanship may justly be described as their wages, they being their own employers. If their wages are to be raised they must somehow increase one or more of the factors on which their success depends. They must be more diligent in the discovery of materials for which a use can be found; they must become better acquainted with the properties of those materials; they must develop their constructive skill. At every step enter the qualities that go to make craftsmanship, as I would interpret the term. There is knowledge of materials, there is imagination, there is technical skill; perseverance is wanted, love of the work itself, sympathy with the use that is to be made of it, and with the user. Clearly, on the craftsmanship of the islanders will depend whether they have enough food to go round, enough clothes to wear, whether they have leisure for anything beyond the labour that satisfies their barest necessities.

Nor is the account yet complete—far from it. It is not only that the products of craftsmanship are a necessity if the islanders are to live at all; craftsmanship has a value in itself. There is in men, more in some, less in others, the natural desire to use what faculties they possess. It is a fact that love of good work and delight in successful accomplishment are powerful motives, and when satisfied are sources of real happiness. Of all the motives that sway the world, these are among the purest and best. The power to produce in plenty what is wanted is, of course, only one of the great problems that a community has to consider. There is also the endlessly difficult question of distribution, of the manner in which each working individual is to receive his share of the wages.

Let us extend our image a little. Let our island be discovered and put into communication with the outside world. An exchange of craft work sets in. The islanders discover new wants that must be satisfied and they pay for the necessary imports by exporting what they make themselves. But the exports must be made to satisfy the tastes of the outside peoples or there will be no trade. So the islanders now find that they must no longer consider their own tastes entirely. They must accommodate themselves to a more general conception which is only in part their own. We may say that their craftsmanship is now judged more critically; and more than ever it becomes fundamental to well-being, even to existence. The conclusion I would draw from this very simple little analogy is that a people lives on what it makes or earns and that its success depends on its craftsmanship. A people cannot expect to be provided for; it has no rights.

I would ask you presently to consider the difference between the craftsmanship of an early civilisation and that of our own more complicated times. But before doing so, let me say yet one or two words about the older forms.

We have a profound feeling for any example of an old craft, and for very good reasons. Among them I do not include the sentimental regret that, in some cases, a past time skill seems to have disappeared. Our affection for it, and the reverential care with which we handle it are due to the fact that it represents to us the labour of a people, labour into which knowledge, imagination, love of beauty, technical skill have all entered. The most of what was once used in every-day life has long disappeared; even such more durable things as houses and ships, roads and cultivations may have ceased to be. The few objects that survive must be taken as examples of what has been lost. And on the showing of the student a spirit will emerge from an old vessel as great as

* British Association, Glasgow, 1928. Presidential Address—Abridged.

that which issued when the fisherman of the Arabian Nights unsealed the pot that had long been lying at the bottom of the river. It is the spirit of the bygone people that takes shape before us. It is indeed well known to you all that the craftsmanship of a people is an expression of the best of its very self. It is to the underlying reason that I would draw your attention now. The mind of a nation is so expressed because its craftsmanship, interpreted in its widest sense, represents its efforts to live. Under this strong compulsion the nation produces results which range from pots to poetry, and all its products are stamped alike. That which we do ourselves is as representative as a Greek vase or a Roman aqueduct or a suit of armour from Milan. The craftsmanship of a nation is its very life. Even if we consider it only in relation to the production of material things, the state of a nation's craftsmanship is an index of its health.

As a people departs from its primitive condition, so also does its craftsmanship. I would ask you to consider the nature of the change. The elements of craftsmanship in its original form centre round the individual. In his brain is the knowledge and imagination, in his hands is the skill, and round about him lie the materials and the tools of his craft. But as the years go by it becomes impossible that all the knowledge and all the technical skill should be found in one person, and all the tools be owned by him. The craftsman becomes an association of men, a great manufacturing firm even, we might say, a nation, if all the members of the nation contribute through Government intervention and control to the maintenance of some industry. If now we ask ourselves what has brought us to this new kind of modern craftsmanship, this dependence on machinery with its wealth of production, its clattering, bustling activity, and its compelling influence on the lives of all of us, we find that one simple cause has been continuously operative. It is nothing more nor less than the urgent wish of the individual to better his own condition, and, in his disinterested moods, the condition of his neighbours. The change could never have been prevented.

When Hargreaves thought that by a mechanical arrangement he could manipulate several spinning wheels at one time, and succeeded, so that he had more wages to spend on his wife and children, he was obeying a universal and natural impulse. Hargreaves' neighbours, being left behind in the competition for wages, pulled his house about his ears. But in the end, they, too found themselves to be turning many spinning wheels where formerly they had only handled one. Then they, too, had more money to spend. What other turn could things have taken under the circumstances? What happened in this isolated incident is repeated again and again in every craft, and in sequence change and change marks the road that stretches far from its beginnings.

Quite apart from all considerations as to whether the new is better or worse than the old, more beautiful or less beautiful, whether it calls out the best in man as well as the older ways, or whether it fails to do so, apart from all comparisons of this kind stands the fact that the change is due to natural impulses which will not be gainsaid. The results have to be accepted. We cannot put the clock back. We cannot, let us say, wipe away the great steel works of the world and replace them by thousands of individuals each with his single anvil and single hammer. We cannot replace the great ships of Glasgow by a multitude of little sailing boats. The plain truth is that modern craftsmanship with all its noise and ugliness is giving food and clothing, warmth and interest to millions who otherwise must die. It is ungrateful to find fault except with sympathy. Let us try in all possible ways to mend its offences and soften its hardships, but in all honesty let us recognise that we live on modern craftsmanship in its modern form. We are each and every one of us responsible for the present conditions as long as we insist on spending money to the best advantage.

At this point it is convenient to refer to a matter which would be of little importance if it did not seem sometimes to put modern craftsmanship in a wrong light. We are continually discovering instances of the marvellous skill of the craftsman of thousands of years ago. There is here, however no disheartening implication, as has sometimes been asserted, that men can no longer do what was once in their power. To those who look into what goes on in a factory or a mine, in the field or on the sea, there are innumerable instances of beautiful craft work, beautiful because of their fitness for their purpose, their balance of design, their ingenuity, their history, their growth under human perseverance and thought. Every one of us can bring to mind instances of technical skill demanding imagination and intelligence as well as manipulative power which could be set alongside any instance in history. Let me name only one. Could anything surpass the drawing of fibres of quartz, finer by far than a human hair, by means of the bow and arrow? It was a feat to imagine that it could be done, to anticipate that when done it would fill so perfectly an urgent need in the construction of many important instruments, and, finally, to do it.

Now we come to the point at which I would ask you to consider the relation of science to the craftsmanship which I have been trying to define. I would draw your attention to the manner in which, under the urgent drive of self-preservation, the craftsman has called scientific knowledge to his aid. Sometimes the moment has been dramatic on account of the great need of the occasion and the prompt effectiveness of the reply. When, for example, coalmining was at a low ebb because the mines were becoming waterlogged, and no available power was strong enough to clear them, Savery and Newcomen made use of the new discoveries respecting the pressures of gases and vapours which Torricelli and Pascal, Papin and Hooke, had just been examining and trying to explain. The steam engine thus came into being and saved the situation. And when, at a somewhat later date, your own citizen, James Watt, by further application of the same physical laws, added fresh powers to the engine, the modern steam engine came into view, with all its applications to railways and steamships and many other marvels of to-day. In 1831 Faraday, in the course of certain systematic searchings, found out the way in which one electric current could bring another into being, the so-called electromagnetic induction. With that single day's work began the whole development of electrical engineering in its innumerable forms. I need not increase the number of my illustrations.

More often it happens that scientific knowledge enters with less instantaneous and startling effect into the history of a craft. It is only when you come to consider the various details of some modern product of craftsmanship that you suddenly realise how closely every detail is connected with the advance of science, and, indeed, to be more particular, with the scientific laboratory.

If you hinder the growth of science in any way, you hinder the growth of craftsmanship. Now it is an important fact that science advances over a wide front, and the various branches of it move on together: not absolutely keeping step with each other, but preserving a general line. It has been suggested that science might refrain from development in some directions, or, even as our good friend the Bishop of Ripon said at Leeds last year, we might proclaim a ten years' holiday. But you cannot prevent interested men from making inquiry. You cannot prevent the growth of knowledge, you cannot even make a selection of those points of advance which will lead to certain select classes of results. No one knows what is over the hill. The vanguard moves on without any thought of what is before it. That is why, if the march of science is to be conducted in an effective and orderly way, were it only for the purposes of industry, there must always be a certain number of laboratories or parts of laboratories where scientific research has no immediate thought of possible applications.

If I read modern industrial conditions rightly, the closeness of the connection between craftsmanship and science may be illustrated in this way. It is, I think, a fact, and a remarkable fact, that the most active of our modern industries are those which are founded on recent scientific research. The most notable is, of course, that of electrical engineering. The year that sees the celebration of our Association's centenary will witness also the ceremonies that commemorate the basic experiment of Faraday. It is difficult to sketch in a few words the great edifices that have been built upon the discovery of electromagnetic induction.

Though the electrical engineering industry with all its branches may be said to have its source in a single laboratory experiment, yet it has grown by the continuous adaptation of fresh streams of knowledge. The huge American corporations maintain research laboratories costing millions of pounds anually, and find that the financial return justifies their policy. The General Electric Company found that a costly research into the structure of the electric lamp repaid itself over and over again. The very important technical discoveries of Langmuir and Coolidge were consequent upon an attempt to find out what happened on the surfaces of the glass bulb and of the glowing filament. The point is that the electrical industry was not merely launched by a single discovery; it is continually guided, strengthened and extended by unremitting research.

Consider the very active motor industry. The most important of all the problems connected with the internal combustion engine is that of the nature of the explosion, the effects of varying the mixture, the movement of the gas in the cylinder before the ignition, the actual occurrences at the moment of ignition, the movement of the subsequent explosion wave. The problems are exceedingly intricate. They have been and are the subject of intense research in various laboratories in this country. The research is new and the industry is new. The construction of the engine depends on the use of alloys possessing the most remarkable properties, all of which were practically unknown until recent researches of the metallurgists brought them to light. The motor car is connected, too, with the laboratories in which chemistry and physics are applied to the study of rubber. Here, again, is a whole story in itself, which would tell of the work done on the intricate consequences of various kinds of mixings and of treatment, of the vulcanising and of the use of "fillers." Not many know the story. They are only aware that motor car tires last longer than was once the case.

The aeroplane, like the motor car, has become possible because of the advent of the internal combustion engine; but it has a unique feature—its element of romance, its motion through the air. The laws of aerodynamics are becoming better known, and with every advance in their knowledge the efficiency of the aeroplane increases. Their intricacy is gradually resolved, but the process demands, in the first place, mathematical skill, and, in the second, the fascinating research that is carried on in the wind channels of our laboratories. On this splendid work the progress of the aeroplane depends. I saw not long ago in a London shop window a coloured print of a flying machine. From across the street it might easily have been taken for a drawing of a modern aeroplane; a closer view showed still the same general spread of wings, the same whirling screws, the same discharge from the exhaust, a boat not at all untrue to modern design, and wheels to bear it when on land. Moreover, the proportions were quite familiar. Yet the date was 1843. For all its resemblance to the modern aeroplane, how far it was from flying not only in time, but in capacity! The difference between old and new in the form and materials of the wings may not be obvious to the casual observer, but in reality a wealth of trial and calculation lies between the crude projections of the old invention and the modern machine that flies. The turn of a line in the sectional outline of the wing may make the difference between success and failure, though it is only one of innumerable and equally essential details. The scientific worker grasps the meaning of that turn, and the airman tries it out, and that is the combination which brings success at last. The point is that the construction of the flying machine is a new industry based directly on knowledge recently acquired in the laboratories, and continually growing under laboratory experiment. Everything depends on this careful, well-informed concentration on essential details.

If we enter the chemical province we find that there are thriving industries based on recent scientific discovery; instances at least as remarkable as those possessing a more physical basis. The chemical industries are so many and various that even a brief summary is beyond me; yet the whole of them are of comparatively recent origin. Quantitative chemistry is little more than a century old. And the more modern and more vigorous of the chemical industries depend on very recent chemical research, as, for example, those which deal with dyes, explosives, fertilisers, rubber, artificial silk, and many other things. It is the same story—the craft is based on science, and in this case very obviously so. Chemical industries are based on scientific discovery and lean on it the whole time.

It is natural to compare the condition of the newer industries with the older industries known as basic, because they have long constituted by far the major portion of the country's industrial effort and are still pre-eminent—coal and steel, cotton and wool. In some of these industries there is serious depression. What has the fact to do with science and scientific research?

It is obvious that we cannot say of any industry or craft that its condition depends only on scientific knowledge and imagination. The difficulties of the coal trade are due in large part to the powerful cause of competition. The situation is not wholly irremediable, though the older conditions can never completely return. But at least a partial retrievement is possible, and we know that various research organisations, some instituted by the State and some due to private enterprise, are grappling with the question involved. It is deeply interesting to see in what way the necessary efforts are being made, and indeed must be made.

Now, whatever is done, and in whatever way it is done, the results of such endeavour, whether related to the coal or to any other industry, depend on those relations between craftsmanship and science which I have been trying to define. I would now consider these relations from one or two separate points of view. In the first instance, let me say a word concerning the general connection between science and that condition in industry which is known as mass production.

It must always be the aim of an industrial organisation to devise and set going one of those systems of manufacture on a large scale with which we have become familiar in recent years. With the aid of suitably designed machinery and methods, great numbers or quantities of some article in general demand can be produced at a comparatively small running cost. Generally, however, the initial cost is heavy, for the designing of the machinery and the planning of the methods call for great experience and skill, and they demand much time spent in the acquirement of the necessary knowledge and its utilisation in design. Once the process is under way it may be possible, and it seems to happen on a sufficiently attractive number of occasions, that a smooth and peaceful running of the machinery brings in the wished-for returns. But every such phase of production comes to a natural end. An improved process is devised, and the new displaces the old. Or it may be a factory is set up in another country where labourers can be hired more cheaply; they may be intrinsically inferior, but that will not matter if they can be drilled into the mechanical process; and, as long as the machine runs true the standard will not fall below a certain value. The event is in accord with expectation because men will always try to improve their productivity by the use of new know-

ledge or more favourable conditions, so that those who fail to recognise the principle will be left behind by those who do not. The stereotyping of some process can only be fruitful for its allotted time. Mass production is in its way splendid, ministering to the necessities and conveniences of many who must otherwise have gone without. But if it is brought to such a pitch that its processes call for little intelligence in their working, then cheap people of little intelligence will be found, in the end, to be in charge.

The relation of science to mass production is therefore both that of builder and that of destroyer. Mass productions are temporary lulls in the movement of imagination and knowledge. Much skill and thought and care may be required to arrange for one of those quiet and profitable times; the machine is set going and for a while goes by itself. But new applications of scientific knowledge, new ideas, new processes, new machines must always be in preparation. In the parks the gardeners are always nursing fresh plants to take the place of the old, and preparing them for their useful time of flowering. And so we see the meaning of the various research organisations which have been set up in the basic industries, such as the Fuel Research Board, the Cotton, the Woollen and the Silk Research Associations, the research laboratories of the steel masters at Sheffield. Much of our hope for the future is built upon their work.

If craftsmanship, to fulfil its task of providing for the people, must be continually improving its processes, then the nation that is to be successful must possess the means and the will to improve, and here we come, I think, to a notable point. May it not be said that in this country the means exist even to a remarkable degree? Should it not, therefore be our policy to take advantage of our country's qualities by continually seeking for fresh industries or fresh adaptations of the old? We should not surely cling unduly to older activities when they have reached the stage in which many others have learnt to do them with equal efficiency, and when we can go on to something new and, it may be, more difficult. We can, of course, bolster up old industries by political methods, and I have no wish to decry such methods as always incorrect. But clearly the best protection of all is the knowledge and skill which can enable us to produce what others must ask us for because they cannot so well make it themselves.

These considerations lead naturally to a second aspect of the relations between craftsmanship and science. The improvement of craftsmanship depends in large part on the absorption and adaptation of scientific discovery. How is the process to be encouraged?

We here come to a point which must be emphasised with all possible vigour, because its importance is not always realised. Scientific knowledge and experience if it is to be of full service must be in direct practical contact with the problem that is to be solved. This must be clear to every one of us from actual experience. If you have expert knowledge on any subject and your advice is asked, your first instinct is, as you all know, to ask to be allowed to see for yourself. It is only when all the circumstances are clear to you in their relation to the difficulty that the solution is likely to suggest itself. And it may take much watching and patient observation before you are successful. It is the combination of actual experience with scientific knowledge that is essential. As the principle is so fundamental, I may be allowed to illustrate it by an actual experience:—

It was in the early years of the war that a body of young scientific students from our universities was assembled for the purpose of testing on the battlefield the value of such methods of locating enemy guns as were already known. In their mutual discussions and considerations it became clear to them that the great desideratum was a method of measuring very exactly the time of arrival of the air pulse, due to the discharge of the gun, at various stations in their own lines. If the relative positions of the stations were accurately known, it would then become a matter of calculation to find the gun position. But the pulse was very feeble; how could it be registered? Various methods were considered, and among them was one which no doubt seemed far-fetched and unlikely to be successful. A fine wire is made to carry an electric current by which it is heated. If it is chilled—for example, by a puff of cold air—the resistance to the passage of the current increases, and this is an effect which can be measured if it is large enough. If, then, the hot wire could be made to register the arrival of the air pulse from the gun a solution of the problem was at hand. No doubt, this method occurred to several members of the company; it was certainly turned over in the minds of one of them who had had considerable experience of these fine heated wires. They had been in use about thirty years, having been employed for the measurement of temperature in many circumstances, where their peculiar characteristics gave them the supremacy over thermometers of the ordinary form. But, and this was the important point, was it to be expected that the effect, though it must be there, would be big enough to see? Could the faint impulse from a gun miles away produce an obvious chill in a hot wire? On first thoughts it did not seem likely, and the suggestion lay in abeyance.

But it happened that one summer morning an enemy aeroplane came over at daybreak on a patrolling expedition. The officer of whom I have spoken lay awake in his bunk listening to the discharges of the anti-aircraft guns and the more distant explosions of their shells. Every now and then a faint whistling sound seemed to be connected with the louder sounds. The wall of the hut was of felt; it was in poor condition, and there were tiny rents close to his head as he lay. The gun pulses made a feeble sound as they came through. This set the officer thinking; if the pulse was strong enough to make a sound, it might be strong enough to chill a hot wire perceptibly. So the method was proposed to the company as worth trying. It was tried, and proved to be a complete success. The sound ranging of the British armies was based upon it, with results which have already been described and are fairly well known.

It is clear that the all-important suggestion could only have been made by a man who had had scientific training and experience. That is one point of the first significance. The second is that it could only have been made by such a man actually on the spot. He could not have realised the details of the problem if he had been anywhere else.

It is worth while to consider this last point a little more closely. What precisely was the difficulty which could only be resolved by a combination of knowledge and of being on the spot? It was really the difficulty of making a true estimation of quantities. It was a question of magnitudes and measurements. Anyone possessed of scientific knowledge could have said, if asked, that a gun must make an air pulse, and that an air pulse would chill a hot wire to an extent which might or might not be measurable. But there is all the difference in the world between such vague general knowledge on the one hand, and on the other, the realisation that such a method is likely to work and give the desired result. It is the difference which so often escapes attention, but everyone of experience knows that it is to be reckoned among the essentials. It is so easy to talk generalities or to think of them, and so difficult to get down to the details which make the effort a success. It may be the last little adjustment of magnitudes that turns the scale, and the last step the one that counts.

Are we, then, in this country, putting our scientific knowledge into the position where it is really effective? I would draw your attention to a most interesting and important movement which is attaining a notable magnitude.

A new class of worker is growing up among us consisting of the men engaged in research associations and industrial research laboratories throughout the country. We must place a high value on their services, for they are actually and personally bringing back with them into craftsmanship the scientific knowledge which is one of its essentials. They bring the interest and the outlook of scientific inquiry into touch with both employer and employed, and I cannot but think that they may be to some extent the flux that will make them run together. For they can speak with the employer as men also trained in university and college, exchanging thought with ease and accuracy. And, at the same time, they are fellow-workers with those in the shops, and can bring back there some of the interest and enthusiasm which springs from the understanding of purposes and methods. It is to be remembered always that personal contact has, on the whole, thanks to the better qualities in human nature, a marvellous effect in smoothing out differences. I do not think it is unduly optimistic to welcome the growth of this new type of industrial worker because it can, being in personal intercourse with both capital and labour, supply to each a new outlook on their whole enterprise, especially as that outlook is naturally illuminating and suggestive. For, after all, this is but going back to first conditions. The primitive craftsman has been replaced by separate persons or groups of persons who have slipped away from each other almost without our realising the fact. In the most recent times the separation has become more obvious and more dangerous, and that is why in so many directions efforts are being made to stem it. Can it be good that the workman has a part demanding little intelligence, merely the capacity to repeat? Can it be expedient that mere manipulation should be left in the shop, while design and imagination have gone into the drawing-office and shut the door behind them? Can it be right that the factory directorate should not be in immediate contact with the vast body of scientific knowledge?

I doubt if there is, in the first place, sufficient appreciation of the interests and rewards in the life of a student of industrial research. The pioneers have suffered unnecessary restrictions and discouragements, but their followers will be in better case. Surely it does not need much imagination to realise the splendid side of such work? The succession of fresh difficulties to be overcome, and of new and interesting views into the nature of things and ways of the world; the unforeseen value of results, sometimes an immediate prize, sometimes the clearing of an obstacle in a manufacturing process, never less than the discovery of facts which may some day be of use; the personal association with a living enterprise and with the human spirit behind it. And when it is realised that this kind of work is wanted badly, that it is really serviceable to the community, that there is opportunity for devotion, that it is in touch at once with human needs and with the furthest stretches of thought and imagination, it surely takes on to us the final touch of nobility.

Nothing in the progress of science, and more particularly of modern science, is so impressive as the growing appreciation of the immensity of what awaits discovery, and the contrasted feebleness of our ability to put into words even so much as we already dimly apprehend. Let me take an example from the world of the physical sciences. There is a problem of which the minds of physicists have been full in recent years. The nineteenth-century theory of radiation asks us to look on light as a series of waves in an all-pervading ether. The theory has been marvellously successful, and the great advances of nineteenth-century physics were largely based upon it. It can satisfy the fundamental test of all theories, for it can predict the occurrence of effects which can be tested by experiment and found to be correct. There is no question of its truth in the ordinary sense.

In the last twenty or thirty years a vast new field of optical research has been opened up, and among the curious things we have found is the fact that light has the properties of a stream of very minute particles. Only on that hypothesis can many experimental facts be explained. A wave theory is of no use in the newer field. How are the two views to be reconciled? How can anything be at once a wave and a particle? I do not believe that I am unjust to any existing thinker if I say that no one yet has bridged the gap. Some of you who were present at the Liverpool meeting may remember that Bohr—one of the leading physicists of the world—doubted if the human mind was yet sufficiently developed to the stage in which it would be able to grasp the whole explanation. It may be a step forward to say, as we have been saying vaguely for some years, that both theories are true, that there are corpuscles and there are waves, and that the former are actually responsible for the transference of energy in light and heat, and for making us see; while the latter guide the former on their way. This is going back to Newton, who expressed ideas of this kind in his "Opticks," though he was careful to add that they were no more than a suggestion.

We are here face to face with a strange problem. We know that there must be reconcilement of our contradictory experiments; it is surely our conceptions of the truth which are at fault, though each conception seems valid and proved. There must be a truth which is greater than any of our descriptions of it. Here is an actual case where the human mind is brought face to face with its own defects. What can we do? What do we do? As physicists we use either hypothesis according to the range of experiences that we wish to consider. To repeat a phrase which I employed a few years ago in addressing a university audience familiar with lecture time-tables, on Mondays, Wednesdays, and Fridays we adopt the one hypothesis; on Tuesdays, Thursdays, and Saturdays the other. We know that we cannot be seeing clearly and fully in either case, but are perfectly content to work and wait for the complete understanding.

Surely it is the same in regard to less material affairs. The scientific worker is the last man in the world to throw away hastily an old faith or convention or to think that discovery must bring contempt on tradition. The proper employment of scientific research is so necessary to our welfare that we cannot afford to allow misconceptions to hinder it; and the worst of all are those which would suppose it to contradict the highest aims. Science, as a young friend said to me not long ago, is not setting forth to destroy the soul of the nation, but to keep body and soul together.

And some perhaps might say that in considering science in relation to craftsmanship, I am pressing the less noble view; that I am not considering knowledge as its own end. It is said that uselessness in science is a virtue. The accusation is a little obscure because it may justly be said that knowledge is never useless. If I have thought of science in relation to craftsmanship, it is because I have tried to set out the vast importance of what craftsmanship means and stands for. I have not forgotten that there are other aspects of the inquiry into the truths of Nature. Indeed, I could not carry out the lesser task without considering the whole meaning of science. And no clear line can be drawn between pure science and applied science; they are but two stages of development, two phases which melt into one another, and either loses virtue if dissociated from the other. The dual relation is common to many human activities and has been expressed in many ways. Long ago it was said in terms which in their comprehensiveness include all the aspirations of the searcher after knowledge: "Thou shalt love the Lord thy God with all thy heart and with all thy soul and with all thy strength," and "Thou shalt love thy neighbour as thyself." In the old story every listener, from whatever country he came, Parthians and Medes, Cretans and Arabians, heard the message in his own tongue. A great saying speaks to every man in the language which he understands. To the student of science the words mean that he is to put his whole heart into his work, believing that in some way which he cannot fully comprehend it is all worth while, and that every straining to understand his surroundings is right and good; and, further, that in that way he can learn to be of use to his fellow-men.

A Visit to the Benjamin Electric Company's Works.

A FEW days ago we were invited to inspect the works of the Benjamin Electric Company at Tottenham. The company was established in 1908, and commenced operations at Rosebery-avenue. From the outset the concern has specialised in the manufacture of scientific electric lighting equipment, notably metal reflectors, which have been supplied to many parts of the world. Owing to the expansion of business, it became necessary in 1918 for the firm to move to more extensive premises at Tottenham, and seven years later six new workshops were added to the factory, whilst in 1927 another factory was built, thereby doubling the original floor space. New plant, including large presses for the manufacture of metal reflectors, was installed. An experimental and research laboratory was also put into operation, and a lighting service department was established for preparing lighting schemes for all classes of industrial service. Apart from other work, such as the manufacture of wireless valve holders, Boyce Moto meters, and electric horns for motor cars, the works are capable of producing from 20,000–25,000 reflectors per week.

The new factory comprises eight large bays, with an upper storey, which is used for the executive and general offices, previously situated in the old building, which has been completely reorganised, and is now used solely for production purposes. It consists of eleven large bays, which contain the various production departments. During our tour of the works, we first visited the production office, from which all orders are issued for work to be put in hand, and in which all production records are kept. The production inspection department, which we next visited, controls the inspection of work in progress on the various machines and in press shops, and ensures that all work conforms with the high standard which the firm has always maintained. All the tools used in the manufacture of the various products are made by the firm's own tool makers, and an inspection of the tool store enabled us to gain a very good idea of the large number of different reflectors which the company has to manufacture in order to meet the needs of scientific lighting in all its aspects. Although the factory contains many types and sizes of machines, it is illuminated on the general lighting system, and nowhere is local lighting to be found. Throughout the works the standard of illumination is 10 foot-candles, which is obtained by means of standard Benjamin "R L M" reflectors.

The spinning department, where spinners of many years experience are employed, proved to be one of the most interesting sections of the factory, for it contains machines that are capable of handling spinnings up to 4ft. in diameter. The machine shop is equipped with machines for the manufacture of the various component parts of industrial fittings, and for the production of certain motor car accessories. In the press shop there are batteries of heavy, medium, and light presses for the manufacture of the firm's well-known single-piece "R L M" reflectors, the Benjamin radiator shutter, and other motor car products. In the production of reflectors in one piece the firm has received material assistance from British steel makers, who have produced steel which will stand the stresses and strains involved in shaping from one blank a reflector 20in. in diameter and 17in. high. To preserve the ductility of the metal many processes of annealing and pickling are necessary. The formation of scale must be avoided, as this would seriously affect the coatings of vitreous enamel. In the manufacture of some of the reflectors the metal has to pass through the press seventeen times.

In the production of vitreous enamelled goods the inspection shop plays an important part, as the surface of the metal has a marked influence on the finished vitreous enamel product. In this department the necessary precautions are taken to ensure the quality which the company's clients expect. While it is not a difficult task to produce a single article of exceptional quality in vitreous enamelled ware, the continuity of quality calls for great care. After passing through the paint shop and having examined the enamelling ovens and the sheet metal shop in which the company's shop window reflectors are made, we came to the plating department, where all the products are finished in various styles. Next we visited the assembly shop, the finished stores and the despatching department. In the assembly shop we saw the various component parts of the Boyce Moto meter, and the firm's wireless valve holder. The firm is very proud of its testing and research laboratory.

The highly specialised work of the company has always involved a considerable amount of research and testing, much of which was previously carried out by Commander Haydn T. Harrison in his research laboratory at Canterbury; but when the factory was extended, it was felt that it would be better to carry out the research and testing work at Tottenham. Arrangements were therefore made for the Canterbury laboratory to be housed at the works. The main photometer-room which is not only used for research work, but also for testing the products of the company, contains a photometer, 40ft. long, and it is used for measuring light intensities from fractions of a candle power to over 250,000 candle-power, and for calibrating the Benjamin light meter, the standard measuring instrument used in any large works. The room is divided into two completely separate departments, and the photometer head and measuring instruments are in darkness, thus increasing the accuracy of vision to a very high standard. The tests carried out in the laboratory are based on standards provided by the National Physical Laboratory.

The Frood light and projector flat, situated above the main photometer room, is open to the sky, and also on three sides, thus not only allowing for the projection of beams on surrounding buildings in order to judge the commercial effect, but also projection down on an open space opposite, where the intensity of the light can be measured at considerable distances, thus making it possible to test with accuracy the intensity of the most powerful searchlight beams which often exceed 200,000,000 candle-power. Facilities are also provided on the outside testing area, which is adjacent to the road, for street lighting lanterns to be fixed on brackets at any desired height, so that tests can be carried out on these fittings under practical conditions. In the main testing laboratory the portable instruments used in the works for the Benjamin products are regularly tested and checked, whilst the private laboratory contains the more delicate instruments and standard apparatus for the original research work. The whole of the research and testing work is carried out under the direction of Commander Haydn T. Harrison, who for many years has acted as the company's chief technical adviser, and who is now devoting the whole of his time to the technical affairs of the firm.

A New Print Developing Machine.

SINCE the advent of the dye line photo-print—that is to say, the print which is developed to give a positive directly from the tracing—two styles of which were mentioned in our issue of May 11th in connection with the model drawing-office of B. J. Hall and Co., that firm has felt that there is a necessity for some mechanical means of applying the

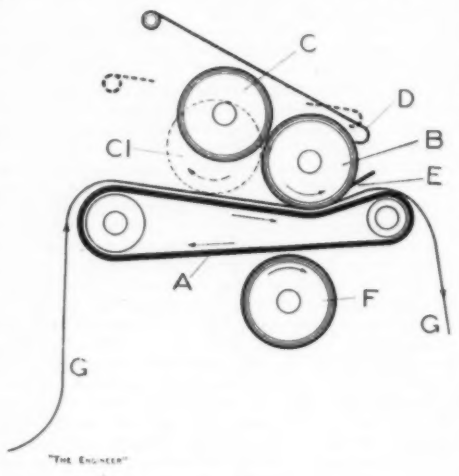


FIG. 1

developer instead of swabbing it on by hand. As a result the machine illustrated herewith has been produced, and we recently studied it in the production of quite a number of prints.

The aims with such a machine are, of course, to apply to the paper only just so much developer as is necessary to produce a permanent print without wetting it to such an extent that it requires subsequent artificial drying; to avoid staining the back of the print; and to reduce manipulation to a minimum. At the same time it is necessary to rub the developer into the surface and to re-absorb any surplus.

The principle of the machine can best be followed with the aid of the end section, Fig. 1. This shows a continuous band of rubber A wrapped round two rollers and driven in the direction of the arrows by a small motor. B is a

FIG. 2

roller, clothed with several laps of an absorbent blanket, revolving, at the point of contact, in the same direction as the rubber band, but at a higher peripheral speed. C is a similarly clothed roller geared together with B. The blankets on these rolls are merely wrapped round several times, so that it is a simple matter to remove them when they require washing. Their function is to distribute the developer over the print. The developer is first applied by means of a bottle—see Fig. 2—which is traversed by hand along two rails running the length of the machine. This bottle is equipped with a drop feed outlet and is manipulated so as thoroughly to soak the blankets at the start of the day's work. Thereafter it is necessary only occasionally to refresh the developer. The drip feed is provided with a stop gear which prevents the waste of developer when the machine is out of action.

The two rolls B and C are mounted in a frame which pivots about the axis of B. This frame is plainly shown in Fig. 3; but it should be borne in mind that Fig. 3 reads in the opposite direction to Fig. 1. That is to say, the front of the machine is on the right in Fig. 3 and on the left in Fig. 1. When the machine is out of action the frame is lifted up by hand, so that the rolls occupy the positions shown in full lines in Fig. 1, and it is held in this position by the pawl D engaging the teeth of the gear wheel on the end of the roll B. F is a clothed roller which rubs against the return side of the rubber band and ensures that it is kept clean and dry.

In operation a print is inserted in the gap beneath the roll C, as shown in Fig. 2, and at G in Fig. 1, and a foot treadle is depressed. This treadle is connected by means of a wire cable with the switch of the driving motor and also with the front of the roll frame. The result is that as soon as the roller B starts to revolve the frame is lowered gently till the roll C takes up the position C^1 shown by dotted lines, resting on the rubber band. Thereafter the pawl D rides over the teeth on the wheel of the roll B. In these conditions the two rolls, turning in opposite directions, distribute the developer over the whole width of the paper, thoroughly rubbing it in, while, in view of the greater pressure between the roll B and the rubber band, the print is definitely fed forward. In order to ensure that the print is fed downward into a receiving hopper beneath and does not travel round with the roll B, light fingers E bear against the back of this roll. These fingers have loose ends brought to a knife edge, so that it is impossible for the paper to

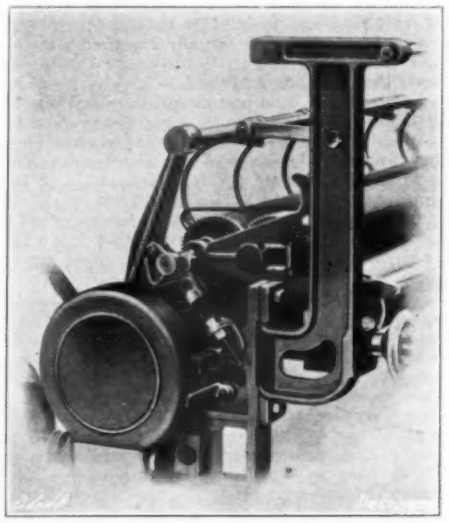


FIG. 3

get behind them. When the print is finished the machine may be stopped, supposing that there are no other prints to follow, by merely lifting the roll frame, as the wire connection with the motor switch cuts off the current.

There are a number of detail refinements about this printing machine which it is hardly necessary to enlarge upon here, as descriptions we have given before indicate that the products of this firm are real engineers' jobs. The completeness of the developing and the dryness of the print are such that it may quite properly put into circulation as it comes from the machine.

American Engineering News.

Motor-driven Live Rolls.

On the roll tables of iron and steel works the group drive has been used ordinarily, the motor operating its group of rollers by means of cables and sheaves or by bevel gears. Several modern works are now using individual motor drive for the rollers, so that failure of one motor affects only one roller, while the breaking of a cable, sheave or gear would put the table out of commission. Besides this, with individual motors, some of these can be cut out of service in order to produce a drag on the strip or bar going through the mill. This system is on the increase owing to the extensive use of anti-friction bearings on electric motors. Power is best furnished by a motor generator set in which a variable speed direct-current motor drives an alternator, so that the speed of the alternator can be varied as desired, thus changing the frequency and voltage of current delivered to the roller motor. Various forms of motors are used for this special work. In many cases they do not require ventilation, except in designs where the motor is mounted inside the roller and is thus subjected directly to the heat from the bar or rod that is being carried on the outer surface. The motors may be mounted directly on the roller shaft or the motor shaft and roller shaft may be connected by a flexible coupling. Strong construction and effective insulation are necessary in motors for this class of service.

An Elevated Hydro-electric Station.

In planning to develop a normal fall of 15ft. at a dam and lock for slack water navigation on the Kentucky River, there was a difficult problem in making provision for flood water, as the dam is at a narrow part of the river, so that the overflow length is small, while floods may give a depth of 27ft. on the dam. At the same time the high cliffs prevented the building of a power station anywhere except upon the dam. To put the station in this position and at the same time avoid shortening the overflow section of the dam by building the power-house upon it, the expedient was adopted of building tall thin piers upon the dam to carry the power-house about 50ft. above the normal

water level in the forebay. Each pier spans a wheel pit, the turbine shaft extending up through the pier and carrying an 800 kW generator in the building. As all machinery has to be delivered on barges, the walls of the building are surmounted by rails for a 15-ton gantry crane, the beam of which extends over both the forebay and tail race, so that the hoisting trolley can stand over barges above or below the dam. The building also has a low flat roof with hatches through which machinery can be lowered into place or removed for repair or replacement.

An Old Steel Arch Bridge.

The notable steel arch bridge designed and built by James B. Eads to cross the Mississippi River at St. Louis in 1874 is in practically perfect condition and quite able to carry the loads of to-day, according to a report made by a board of engineers. This investigation and report was made in view of certain alarmist claims that the bridge was likely to collapse and cause a disaster. There are three arch spans, the middle one of 520ft. and the others 502ft. in the clear. Each span has two arch ribs and each rib is composed of two tubes connected by vertical and diagonal truss members. These arches carry a double-deck superstructure having a highway and electric tramway on the upper deck, and two lines of railway on the lower deck. Special interest centres in the arch ribs or tubes, which are built up of longitudinal staves of chrome steel fitted to sleeve joints to which also the truss members are attached. This early use of heat-treated chrome steel is remarkable, but Mr. Eads was a very progressive engineer, and he not only designed the bridge but made the specification for the steel, supervised its manufacture, and also supervised the construction of the bridge. Every single stave was tested to a proof load of 50,000 lb. per square inch. All the metal is in excellent condition, and the bridge has ample strength to carry modern railway trains.

Anti-friction Bearings.

A recent study of the application of anti-friction bearings to machinery used at iron and steel works shows a wide range of application and a great advantage and economy resulting from their use. Thus with loaded ore cars the coefficient of friction with well-oiled ordinary bearings in good condition was 0·034, while with similar cars having roller bearings the figure was 0·0095. On a tilting table where about seventeen brass bearings were replaced weekly, only five roller bearings have been replaced in five years. With travelling cranes, carrying no load, the power required to start the bridge was 4½ times that required to keep the bridge in motion. But with anti-friction bearings, the starting power was no greater than the running power. Cranes of 275 tons capacity have been fitted with such bearings. They not only require a minimum of power but have a smoother acceleration and greatly reduced cost for maintenance and repairs. With such cranes motors of less power are required, thus effecting an economy in cost. These bearings have special advantages also in heavy gearing, as on the pinion and gear shafts of large mill gear-reducing units; also for the high speeds and occasional unbalancing of loads where fly-wheels are operated. In many cases their steady operation and long life have made such savings that they pay their cost in a short time. On hot and cold saws thay have greatly reduced the usual high cost of maintenance of bearings.

Concrete Revetment for River Banks.

In many places along the Mississippi River it is necessary to protect the banks against the powerful erosion of the current, and various methods are used to meet different conditions. Spur dykes or jetties of trees or wire entanglement are sometimes used to check the current and catch drift wood, so that the stilled water will drop its heavy content of sand and mud, thus forming a protective foreshore. Where the bank itself must be covered, it is levelled to a smooth slope and covered with mattress work or other material. In one design, flat concrete slabs are placed overlapping like the slates on a roof. These slabs are 11ft. long and 6ft. wide, 4in. thick, reinforced with wire mesh and having U-shaped rods embedded, so that the projecting ends form loops for attaching to cables in handling and placing the slabs. These slabs were cast in steel forms on barges, the concrete mixer being mounted on another barge which moved along the line of moored barges. In about six to eight hours the forms were removed and placed on the completed slabs, ready for another pouring, a sheet of building paper being placed to separate the slabs. A barge equipped with special tackle lifted the slabs from the supply barges and lowered them into place, starting at a row of header blocks 16in. square, forming the toe of slope and moving inshore 5ft. as each row was laid.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. G. W. BROWN, A.M. Inst. Mech. E., has resigned his position with F. Wigglesworth and Co., Ltd., of Shipley, to join the organisation of Crane-Bennett, Ltd., of London and Ipswich.

THE French Government has conferred the honour of Chevalier of the Legion of Honour upon Mr. Daniel Metz, head of the Citröen Company in England, for distinguished service in fostering business relations between Great Britain and France.

AUTOMATIC AND ELECTRIC FURNACES, Ltd., desirous of conforming more closely to the designation which their customers have themselves adopted, have decided to change the name of the company to Wild-Barfield Electric Furnaces, Ltd. The board of directors and management of the company remain the same.

THE PROPELLERS OF THE "BREMEN" AND "EUROPA."—In referring to the propellers of the new North German Lloyd liners "Bremen" and "Europa" we recently stated in a Journal note of August 24th last that the propellers, although of German design, were supplied by the two leading British propeller firms, both of which have works in London. We are now able to say that the whole order was for twelve propellers. The two British firms to which reference is made are each supplying four propellers, and a further four propellers are being made by a leading firm of German propeller makers with works in Bremen.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Position Mending.

THE multifarious iron and steel consuming industries in the Midlands and Staffordshire are gradually getting back into their working stride, and throughout the area there has been slightly more activity this week. Additional hands are being absorbed into the various trades and material for them to work up is required. Inquiries have been in circulation this week, and increased buying in the near future is practically assured. The market tone has become decidedly stronger. Iron and steelmasters are hopeful for September, and it is confidently anticipated that some, at least, of their hopes will be realised.

Pig Iron Improvement.

A qualified improvement has taken place in the Midland pig iron market. In some instances deliveries against contracts and current sales are in excess of the output, which is an encouraging feature. One make of Northamptonshire foundry iron is reported to have changed hands at sixpence a ton in excess of recent price levels. Quotations have not been generally altered, but there is a marked tendency on the part of smelters to adhere more firmly to their quotations. Price cutting has practically ceased, and the low prices which were taken a few months ago are no longer acceptable. A favourable circumstance, as I pointed out last week, is that consumers' stocks have been kept in most cases down to the barest minimum, so that any general increase in consumption would make itself evident very quickly. At the moment Midland foundrymen are content to buy in very small lots, 10 tons representing many recent orders. Prices quoted on 'Change in Birmingham this week were Northamptonshire No. 3 foundry iron, £2 15s. 6d. to £2 16s. 6d.; Derbyshire, £2 19s. to £3; North Staffordshire, £3 2s. 6d. at furnaces. Forge values are round about £2 13s. 6d. for Northamptonshire and £2 16s. 6d. for Derbyshire.

Finished Iron.

The Staffordshire iron trade continues moderately employed, orders coming through in just sufficient volume to enable mills to keep running. There is little reserve of business, however, in any branch of the trade. Marked bars are maintained at £12 per ton, and are selling better than merchant bars, in which department severe competition is being experienced. Lancashire houses are keen to secure this market, while other outside firms cut quotations severely if there is any prospect of getting business by so doing. Values range from the £9 2s. 6d. of outside sellers to £10 required by Staffordshire ironmasters. The chain, cable and anchor trades of the Black Country are none too busy, so that only moderate supplies of material are called for in this connection. Makers of nut and bolt iron have still to face competition from Belgium, but they are getting a larger proportion of the business going than formerly, despite the fact that No. 3 Belgian iron can be bought at £6 17s. 6d. to £7 delivered in the Black Country, or about £2 per ton below local price. Wrought iron gas-tube strip is selling well, makers having no difficulty in securing £10 15s. for their output. In some cases a slightly higher figure has been paid.

Steel.

In the steel department of the market conditions rule much as last week. The raising, by 1s. per ton, of German billet prices has enabled native producers to obtain something better than £6 2s. 6d. for 2in. billets, and larger sizes have stiffened in proportion. Local steelworks in some instances ask as much as £7 15s. for small steel bars, but where the business is exceptionally desirable they can be bought down to £7 7s. 6d. Belgian steel bars were this week offered at £7 to £7 2s. 6d. The plate mills are working regularly, but the mills making sections are understood to be slack. Finished steel values are unchanged. Constructional engineers have a fair amount of work on hand, but it relates chiefly to small orders. Prices are cut finely for the work to be given out. Other consumers of steel are buying only sparingly. Heavy steel scrap is unaltered at £3 7s. 6d. delivered South Wales.

Galvanised Sheets.

Makers of galvanised sheets report considerably improved business, and many of the mills are now well booked. There is a steady demand for 24-gauge corrugated sheets. Mills have been able to obtain premiums on the basis price of £13 7s. 6d., as much as £13 12s. 6d. having been mentioned. This latter price applies only to sheets for home consumption. Most of the export transactions continue to be put through at £13 7s. 6d. For 30-gauge sheets the price is now £17 5s.

Coke.

The output of coke is being reduced, but it is still more than sufficient for the needs of industry. Blast-furnace qualities can be bought at 12s. to 13s. at ovens.

Manufacture of Stoves at Bilston.

The manufacture of stoves for enamelling, lacquering and core drying is being introduced into Bilston, Staffs. The Bilston Stove and Steel Truck Company has begun the erection of a new factory at the Loxdale Estate, and it is hoped to have it completed before the end of the year. The firm is stated to be already possessed of some big orders for making stoves for drying artificial silk. The growing popularity of this material, it is believed, will provide an assured future for the stove drying industry.

New Coal Cleaning Plant.

An inspection of a new cleaner and of the whole of the surface plant and some of the underground plant of the Cannock and Rugeley Colliery Company was made by members of the South Staffordshire, Warwickshire and East Worcestershire branch of the Colliery Managers' Association, who held a joint meeting on Thursday last week with the South Midland branch of the Association. The new cleaner—a Kirkup coal cleaner—is the first of its kind in the local coalfield. Its function is to separate the shale from the smaller coal by means of the application of air pressure. Coal of 1¼in. size is received into the machine, and, passing over a porous plate, is subjected to an air draught from below. The air, produced by a fan, deposits the coal and the heavier shale into different channels. It was stated that out of the first 50 tons of coal passed through the cleaner 50 cwt. of dirt was extracted. The party also saw the new railway station provided for the transit of the men to and from the pithead. The new Barker screens, capable of dealing with 700 tons of coal a day, the spiral coal separators, the automatic decking arrangement for the cages, new electric creeper for centralising the coal from the two shafts at the one point for screening, the new lamp house for 1200 lamps, the new steel pit-head frame substituted for the old timber frame in the record time of five days, the engine-house and power station, and the underground sub-station and transformer house were also inspected.

Contracts for Midland Firms.

Some acceptable contracts have recently come the way of Midland firms. The Buenos Ayres Central Railway has awarded a contract for six superheated locomotives to Kerr, Stuart and Co., Ltd., Stoke-on-Trent. The Crown Agents for the Colonies have given to the Sentinel Waggon Works, Ltd., Shrewsbury, a repeat order for a steam rail car for service on the Gold Coast Government Railway, while contracts to the extent of approximately £104,000 have been secured by Guy Motors, Ltd., Wolverhampton. The orders, which are for six-wheeled chassis, have been received from the India Office, Wolverhampton Corporation and Reading Corporation.

Edge Tools.

The improvement of the last few months in the Midland edge tool works continues, though here and there the demand is somewhat patchy. There has been an excellent demand from the South American markets, and indications are that business emanating from this region is definitely on the up grade. The Eastern position is scarcely so satisfactory, the increased demand being in the nature of short spurts. Australasian markets have been rather irregular of late, and the current position can hardly be termed strong.

Unemployment.

A further decrease in unemployment in the Midlands is shown by the latest returns, which are smaller by over 7000 than those for the previous week. The decline during the past three weeks is indicated by the following figures:—August 13th, 217,443; August 20th, 212,020; August 27th, 204,745. The number of unemployed in the Birmingham area now stands at 34,011, while the figures for some of the other towns are:—Coventry, 8332; Bilston, 2502; Cradley Heath, 4089; Derby, 3991; Dudley, 3297; Leamington and Warwick, 872; Leicester, 9381; Northampton, 4010; Nottingham, 7908; Oldbury, 1224; Peterborough, 613; Redditch, 1817; Smethwick, 3340; Stoke-on-Trent area, 22,453; Stourbridge and Brierley Hill, 3191; Tipton, 2184; Walsall, 5776; Wednesbury, 1916; West Bromwich, 2983; Wolverhampton, 6832; Worcester, 1176.

LANCASHIRE.

(From our own Correspondent.)

MANCHESTER.

The South Manchester Electrification Scheme.

FURTHER information bearing on the electrification scheme which the London, Midland and Scottish and the London and North-Eastern Railway Companies are undertaking in connection with the Manchester–Altrincham line, reference to which has been made on several occasions in this column during the past twelve months, has been made available this week. The line is to be electrified throughout the distance of about ten miles, at a total estimated cost of £500,000. The scheme will entail the construction of a new generating and distributing station and two new sub-stations, whilst two new passenger stations are to be built along the line, and the railway sheds at Altrincham are to be enlarged and modernised. Current will be supplied by means of the overhead cable system at a voltage of 1500. It has been officially stated that a large number of new coaches are to be constructed. These are to be of the compartment type, as it has been found from experience that they are quicker to load and to unload than those of the open type.

An Aerodrome Wanted.

A special meeting of representatives of business organisations in the city is being convened by the Lord Mayor of Manchester with a view to considering a proposal to purchase a site for the construction of an aerodrome in Manchester. It is believed that suitable land could be obtained within a reasonable distance of the centre of the city. Several such sites are already in view, and the merits of these are to be carefully considered.

Ford's New Move.

The transfer to Manchester of a large share of the activities of the Ford motor works at Cork will probably mean an important extension of the scale of operations carried on at the Trafford Park works. Part of the installation of machinery at the Irish works has already been brought up the Manchester Ship Canal, and it is expected that before very long the present rate of output at the Manchester works of approximately 300 vehicles a week will be considerably extended. According to present

arrangements, it is proposed to concentrate on cars and commercial vehicles at Trafford Park, reserving the Cork works for the manufacture of tractors for agricultural and other purposes.

Salford's New Sludge Boat.

A new sludge steamer constructed by William Beardmore and Co., Ltd., Dalmuir, for the Salford City Council, at a cost of £50,000, has just been placed in commission. Designed for a speed of 12 knots and to carry 1000 tons, it is estimated that on the basis of seven trips in a fortnight from Salford to the sea, the vessel will remove some 166,000 tons a year, allowing for four week's stoppage annually for the purpose of overhauling and holidays. The boat has a length of 240ft., a breadth of 38ft., and is 16ft. deep. It is estimated that the cost of conveyance and dumping of sewage is, in the case of Salford, about 1s. a ton cheaper than by disposing of it by any other means.

Non-ferrous Metals.

In all sections of the non-ferrous metals market this week a steady time has been in evidence, and even tin seems to be recovering from the weak spell which set in late in July. The copper section continues to display strength on the statistical outlook, and though buying by British consumers of the metal is not particularly active, the market is deriving support from the position in the United States and on the Continent. On balance, values are roughly 5s. a ton higher than a week ago. A more "bullish" tone appears to be in evidence in respect of tin. Warehouse stocks in this country, according to the latest official returns, show a decline, the outlook as regards consumption is brightening, and over-production fears, which latterly have had a depressing effect, are less pronounced. The result at the moment of writing has been a rise on the week of about £4 a ton, which more than wipes out the whole of the loss sustained in August. A spurt in the demand for spelter and more restricted supplies of the metal have served to strengthen prices, and here again a net improvement has to be recorded. Lead is particularly firm on comparative scarcity of early offerings, and values have registered a sharp advance during the week.

Iron and Steel.

No appreciable improvement in the demand for foundry iron has occurred since last report. Little forward buying interest has developed yet, and virtually the whole of the week's business has been for limited tonnages spread over short periods. In spite of this, however, sellers have been able to maintain values. Midland brands of No. 3 iron—Staffordshire and Derbyshire—are currently quoted on this market for delivery to buyers in the Manchester area at 67s. to 67s. 6d. per ton. North-East Coast makers hold firm to the 79s. level, with Scottish at 87s. 6d. to 90s., and hematite at 82s. per ton, including delivery to Lancashire works in each case. Local constructional engineers are placing a moderate weight of business in steel, without, however, covering requirements in advance. Inquiry for boiler-plates, both from locomotive builders and from boilermakers, has been rather slow. Quotations seem to be quite firm throughout the range, basic boiler-plates varying from £9 10s. to £9 12s. 6d.; acid plates from £9 15s. to £9 17s. 6d.; general plates at £8 12s. 6d.; sections at £7 12s. 6d.; large bars at £8 17s. 6d.; and small re-rolled bars from £7 12s. 6d. to £7 15s. Continental works are still booking only relatively small orders on this market, but they are sufficiently well placed to be able to maintain prices on a firm basis.

BARROW-IN-FURNESS.

Hematite.

The total output from the eleven furnaces in the district is not being wholly absorbed. At the same time it is expected that an improvement which is long overdue will come about in the next few months. The steel departments are still taking a quantity of iron, and this is having a tendency to keep stocks down. There is a little more activity in regard to inquiries. There is a moderate demand for better qualities of iron, but tonnage is not heavy on the whole. Iron ore continues to be in steady but moderate demand. Foreign ore is being imported in restricted quantities. The steel trade continues fairly quiet, and makers are engaged upon orders booked some time ago when the mills were idle.

Submarines.

In connection with the launch of the submarine "Otus" at Vickers-Armstrongs, Barrow, last week, which, by the way, is the last of the "O" class which Barrow will build for the Admiralty, it was stated that there were three submarines building on the stocks for Chili, and that these vessels are similar in design to the "O" class; the British Government having given their permission for the "O" design to be adopted. These three submarines are in a forward state on the stocks at present. Next year Vickers will be constructing at Barrow submarines of the "P" class, for the British Admiralty, and there will be four of them according to the present programme.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade Duiness.

THERE is a general feeling throughout the country that the iron and steel trades are on the eve of improvement, and the Stock Exchange is showing more interest in some of the companies. The optimistic view is not absent in Sheffield, but at present there is no great sign of any forward movement in industry, except in the open hearth steel department, and even in that there is no undue pressure for deliveries. It is hoped that the advent of the autumn buying season will enable more basic furnaces to be started. There are encouraging reports from other centres which produce basic steel, including Lincolnshire, where the plants are doing much better, and the indications are that progress will be maintained. It is not thought that continental prices are likely to fall to the level which has enabled them to make such inroads into British trade during recent years, and when buyers of the cheaper classes of steel are assured of this, they should be prepared to place forward contracts with more readiness than they are doing at present. It is bulk orders that are badly needed; much of the present business is of a hand-to-mouth character that makes the profitable running of plants extremely difficult.

A Busy Company.

It is very refreshing to come across an instance of a firm, especially if it be a large one, which is busily employed. There are several of these bright spots in Sheffield and district, and one of them consists of the local group of works belonging to the United Steel Companies, Ltd. At these works the production of ingots for billets is running to between 10,000 and 13,000 tons per week, the actual figure for the week before last being 12,226 tons. Maximum capacity is being worked at the big mills at Templeborough, and the plant is being extended in order to secure increased production. At the adjoining strip and bar mills also employment up to full capacity has been maintained for some weeks, and the bar mill recently established a record by producing 3457 tons of finished bars in a week. Maximum capacity is being worked at the cold rolling and spring shops, and the wire mill is employed full time.

Railway and Other Steel.

The Rotherham tire mill of the United Steel Companies is working up to full capacity week by week, and is getting a good share of the work that is on the market. Generally speaking, however, the plants in the district devoted to the production of railway material are only moderately employed, as the home companies are still exercising a policy of strict economy in their orderings, and work from overseas is on a small scale. The immediate prospects for acid steel are therefore not very good, although it is felt that the British railway companies must give out specifications for larger supplies in the near future. It is difficult to secure orders for heavy engineering work, and there are many complaints of the severity of foreign competition. In spite of this competition, however, the Brightside Foundry and Engineering Company, Ltd., has during the past year obtained a contract for a 35in. roughing mill for India, which is now nearing completion at its Ecclesfield works. There is a fair amount of business in medium and lighter castings, although much more work would be welcomed. The demand for special steels has recently shown a falling off, but this phase is only regarded as temporary, and, in view of the number of inquiries afoot, an early improvement is expected. In the lighter department of the steel trade, one of the busiest sections is that of hacksaw manufacture, which shows continual expansion. There is a good deal of activity at the Derbyshire pipe foundries.

Cutlery and Plate.

Some improvement is reported by certain firms engaged in these trades, as a number of good contracts have been placed recently. The industry generally, however, shows little progress. Apart from the demand for stainless cutlery of the cheaper grades, the general trade through ordinary distributing sources is poor. An improvement is looked for, however. There are many inquiries afoot, and these stimulate hopes of a brisk trade in the autumn. The making of safety razor blades continues to be a very active industry, and there is a steady increase in exports of these implements.

Sheffield's New Waterworks.

The Corporation of Sheffield is now taking the final steps for increasing the water resources of the city by almost a third. This has been rendered possible by the construction of two reservoirs in the Ewden Valley, only a few miles from the city, which have a total capacity of 1,756,000,000 gallons. The works have been in progress, subject to some interruption by the war, since 1914, and have cost about a million and a quarter sterling. The larger of the two reservoirs is that named Broomhead, which has a drainage area of 5427 acres and a capacity of 1,210,000,000 gallons. It has a surface area of 122 acres and a greatest depth of 93ft. Its embankment rises to a height of 100ft. above the river bed, is 1000ft. long, and has a cubic content of 650,000 yards. The discharge tunnel is 1100ft. long, and the trench 158ft. deep. In the case of the More Hall dam, the drainage area is 1069 acres; surface area, 68 acres; capacity, 546,000,000 gallons; greatest depth, 73ft. The greatest depth of the trench is 103ft.; the embankment rises 80ft. above the river bed, is 920ft. long, and contains 350,000 cubic yards. The discharge tunnel is 761ft. long. The watershed has an available yield of 7,249,000 gallons per day, of which 2,629,000 gallons are required for compensation purposes, leaving 4,620,000 gallons as an addition to the city's present daily supply. Both dams are now practically completed; the sluices have been closed, and the first dam is being filled. A main, composed of 36in. cast iron pipes, is being laid to convey the water to the city.

A Colliery Dismantled.

The depression in the coal trade continues to receive emphatic illustrations in the closing, temporarily or otherwise, of local collieries. At the Barlborough Colliery of the Staveley Coal and Iron Company, dismantling has been in progress for some months, and last week the last tub of coal was drawn preparatory to the closing down of the pit. Until the trade depression set in, the colliery provided work for over 1000 men and boys, and recently about 100 have been at work on day-to-day contracts, which have now automatically ceased. Over 500 men, formerly employed at the Southgate Colliery, Clowne, in the same district, are now out of work, owing to coal drawing having been reduced to one shift per day. At the Cortonwood Colliery, over 1250 men and boys employed in the Swallow Wood seam have received seven days' notice to terminate their engagements, owing to the present state of the industry. There appears to be little present prospect of the men being re-engaged for work in other seams.

A Leeds Tube Contract.

The Yorkshire Copper Works, Ltd., of Leeds, has obtained an order for cupro-nickel condenser tubes for the latest extensions of the Bunnerong power station of the Sydney Corporation electricity department. The same company has recently secured important contracts for the P. and O. Line, the steamship "Viceroy of India," five vessels for the Canadian Government merchant service, and for land power stations.

Grimsby Dock Extensions.

For a considerable time those engaged in the fishing trade of Grimsby have desired an extension of the dock accommodation, which at present consists of two fish docks, linked together. There is no ground for hope that this desire will be realised in the near future. The London and North-Eastern Railway Company are taking active steps with a view to the extension of the present docks and the construction of a new one. Boring operations have been commenced on the site of the proposed dock and a staff of surveyors has been busy obtaining data and levels. A special staff of draughtsmen from the chief engineer's office in London is to be housed close to the site.

At the Seaside.

A scheme is afoot at Bridlington for an extension of the Royal Prince's Parade, and the building of a new theatre. Plans have been prepared by a Sunderland firm of architects. The matter has been deferred for the moment, but there is a probability that it will be taken up again soon. At Skegness a scheme for building a concert hall and refreshment buffet at the entrance to the pier is under consideration. The question of roofing the large central space of the piazza with glass has been considered by the local Council, but has been deferred. The surveyor reported that the approximate cost would be £6500.

Electrical Work for Derby.

Newton Brothers, Ltd., of Derby, has secured an order from the German Government for a 75 H.P., 12,000-volt direct-current generator for the Post Office. They have also received the contract for the electrical equipment of the British Government's super-passenger airship, now under construction at Cardington, near Bedford.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Trade Hopes.

A MORE hopeful spirit now pervades the iron and steel trade in the North of England, and there is every appearance that the worst is passed. Inquiries are expanding on a very satisfactory scale, and September has opened with promise of larger demand than was at one time anticipated. While nothing in the nature of a boom is looked for, considerable market operations are expected to be created by autumn requirements. A most encouraging feature is the steady expansion in exports. Shipments of pig iron abroad from the Cleveland district during August amounted to no more than 8446 tons, but this compares with 7338 tons in July, and is the biggest monthly total recorded this year except in March. Owing to smaller deliveries to Wales, coastwise shipments of pig iron fell from 12,013 tons to 10,562 tons, but some recovery of the Scottish trade is indicated by a rise in the shipments to Grangemouth and Bo'ness from 7101 tons to 8772 tons. Imports of foreign pig iron have ceased, and it is interesting to observe that the month's shipments included 1250 tons to Germany. The manufactured iron and steel shipments have increased by nearly 7000 tons, and amounted to 62,985 tons, a figure which has only twice this year been exceeded. The Indian shipments alone totalled 17,664 tons, and to various ports in South and East Africa 12,836 tons were shipped. There is every indication that the export trade will continue to expand. Activity at works on the Continent, where some firms are stated to be so fully sold that they cannot book further orders except for delivery well ahead, together with steady advance in quotations for foreign material, is strengthening the hands of manufacturers in this area, and promises to divert orders to this district.

Iron and Steel Imports.

Returns issued by the Tees Conservancy Commissioners this week reveal a continued falling off in imports of iron and steel to Tees-side, the decrease in unloadings of pig iron being particularly gratifying. The statistics show the quantities of iron and steel brought into the Tees from Holland, Belgium, France, Norway, Sweden, Finland, India and Germany for the ten months ending August 31st last, together with the figures for the same months a year ago, and for the corresponding period of 1913–14. Pig iron imported to the end of last month amounted to 4928 tons, as compared with 99,781 tons a year ago. Crude sheet bars, billets, blooms and slabs unloaded in the last ten months are given at 145,958 tons, as compared with 187,241 tons a year ago, and 33,646 tons in the pre-war period; while plates, bars, joists, angles, rails, &c., imported to the end of August reached 41,068 tons, as compared with 187,241 tons a year ago, and 19,441 tons in the pre-war period. Imports of all descriptions of iron and steel to the Tees in the past ten months totalled 191,954 tons, as against 333,850 tons for the same months a year ago, and 53,399 tons in the pre-war period.

Cleveland Pig Iron.

Orders for Cleveland pig iron are now being booked a little more freely, and the position is brighter than for some weeks past, owing, no doubt, to the usual

autumn stimulus and also to the fact that consumers who have been holding off the market for a considerable time are now beginning to realise that the trend of prices will more likely be upward than downward. Stocks are low, and signs are not lacking that the restricted output will be fully absorbed. Quantities available for sale in the open market are small, merchants' holdings being light, while makers are conveying a very large proportion of their production direct to their own foundries and steel works for consumption. A certain amount of competition from the Midlands has still to be contended with. Some pig iron producers, who usually draw their supplies from this area, are taking parcels of comparatively cheap Midland brands. Cleveland iron producers adhere firmly to their fixed figures of the last few months, and are encouraged in the hope of arranging contracts on such terms by the less persistent efforts of consumers to break recognised market quotations. No. 1 foundry is 68s. 6d.; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; and No. 4 forge, 64s. 6d.

Hematite Pig Iron.

Steady progress in the right direction is being made in the East Coast hematite pig iron trade despite some competition from West Coast makers. Both home and export sales of East Coast brands, though still light, are somewhat better and stocks promise to be rather substantially drawn upon, as under existing conditions makers hesitate to increase output. Values are hardening, but are well below cost of production. Terms on which contracts are made are a matter of individual bargaining, and vary rather considerably. Customers as a rule stipulate for iron of analysis to suit their particular needs, and recent sales have been made at figures ranging from 69s. to 71s., according to quality.

Ironmaking Materials.

The foreign ore trade remains exceedingly quiet. Consumers continue to be disinclined to negotiate for supplies, but merchants, confident in the belief that quantities available for disposal will be inadequate, are not departing from the firm attitude they have taken for some time past. The end of the ore miners' strike in Sweden has had no apparent influence on the market. Best Rubio ore is still quoted at 22s. 6d. c.i.f. Tees. Durham blast-furnace coke of good medium quality keeps in the neighbourhood of 17s. 6d. delivered at North-East Coast works, but users are not purchasing extensively.

Manufactured Iron and Steel.

While as yet no appreciable expansion of business is reported in the manufactured iron and steel trade inquiries are improving, and the seasonal increase in transactions should commence at any time. The demand for semi-finished steel is showing a steady expansion as the result of the rise in the price of continental material. Finished steel for constructional engineering purposes continues in fairly good request, and sheets are a most active section. Prices are in all departments unchanged.

Big Steel Order for Tees-side.

The iron and steel industries of Tees-side have received a welcome stimulus as the result of the placing of an order for 47,000 tons of rails and fish-plates for South African railway developments with Dorman, Long and Co., Ltd., Middlesbrough. The order, which is one of the largest placed in the district for some years past, will provide work for the three or four months during which delivery of the material has to be made. I understand that the new order will necessitate a resumption of full activity at Dorman, Long and Co.'s Clarence Steelworks, which have not been working at full capacity for several months.

The Coal Trade.

The coal trade position is a little brighter. Already there are indications of a better turn for the steam coal pits, and gas coal collieries, while still dull, are likely soon to experience the improving effects of seasonal trade. August was a depressing month for the gas coal trade, and steams were not much better off. In regard to the latter an improvement has set in, as pits which have been losing a good deal of time are now working more regularly, and a few others which have not lost a day this year, have lately secured one or two big contracts which will see them well into 1929. In a few days tenders will be submitted for some substantial fuel requirements for continental and Scandinavian railway undertakings, and it would be very helpful to Northumberland and Durham to get a share of these orders. There is no difficulty in gauging coal prices, as they are practically fixed, but when it comes to estimating what freight rates may be in the next three months, it is largely guesswork. In August the tonnage market took a turn which completely upset previous c.i.f. calculations. While it would require a large volume of business to affect coal prices, much less might cause coke values to appreciate. The forward demand for coke is strong, and any sudden spurt in the iron and steel trade at home would be likely to have a sharp influence on quotations for patent foundry and other cokes. Best Northumberland steams are still quoted at 13s. 6d., and Durham gas coal is steady at 14s. 9d. Gas coke is firm at 20s. to 20s. 6d.; patent oven cokes, 18s. to 18s. 6d.; beehive and special cokes, 22s. to 27s.

SCOTLAND.

(From our own Correspondent.)

Clyde Shipbuilding.

THE output from Clyde shipyards during August last, amounting to twenty-two vessels of 73,525 tons gross, is the highest for any month this year to date, and the third largest on record for the month of August. Of the twenty-two vessels launched during August last, five were of 6000 tons or over, and the largest of these was the twin-screw motor ship "Rangitiki," 17,500 tons, built for the New Zealand Shipping Company, Ltd., London. Contracts reported during August included the following:—A twin-screw motor ship of about 10,000 tons for the Union-Castle Mail Steamship Company, Ltd., London; cargo steamer of 8000 tons, designed to utilise pulverised coal fuel, for the Berwindmoor Steamship Company, Liverpool; two single-screw motor ships of 4000 tons each; a motor ship of 8800 tons deadweight, for the Australian Steamship Company, Ltd., London; two triple-screw motor ships of 305ft. in length, for the Argentine Navigation Company, Ltd., London and Buenos Aires; and four single-screw motor ships of 4000 tons gross each, for Elder, Dempster and Co., Ltd., Liverpool.

Locomotive Contract.

It is reported that the North British Locomotive Company, Glasgow, has received an order for eighteen 4–6–2 "Pacific" type De Glehn compound superheated locomotives of high power and special design from the Bengal Nagpur Railway Company, Ltd.

Steel and Iron.

A more hopeful feeling exists in the steel trade, owing to better inquiries and a growing firmness in continental materials. An improvement is noticeable in the heavy steel department, some of the works being now fairly well engaged. A satisfactory volume of business is passing in light steel sheets, but there is room for improvement in the heavy gauges. Tube makers are busy in practically all departments. Re-rolled steel bars are fairly busy, and prices are maintained at £7 7s. 6d. to £7 10s. per ton home and £7 5s. per ton export. Pig iron has a poor market, the output from twenty-two furnaces being ample to meet all demands.

Exports and Imports.

During the past week 7800 tons of iron ore and 2500 tons of steel and iron products were discharged at Clyde docks. For the same period exports of steel and iron products amounted to 7000 tons and pig iron consignments reached a total of 886 tons.

Coal.

No change of importance has taken place in the Scottish coal trade during the past week. The shipping department is still very quiet, as buyers abroad cannot be induced to pay the prices asked, either for prompt or forward delivery. For the most part, round coals are moving off steadily, though it is reported that Fifeshire steams have weakened a trifle owing to shippers being unable to arrange suitable tonnage. For the same reason, washed nuts on occasion have sold a shade below current rates. On the whole, however, outputs are easily disposed of at firm prices, which are maintained chiefly owing to the reduced production. Aggregate shipments amounted to 233,855 tons, against 230,070 tons in the preceding week and 252,176 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THERE are some indications of a probable improvement in the conditions in the steam coal industry of this district. It may not be to a marked extent, but it will be something if there is a change from the depressing state which has been experienced for some months past. Shipments last week, it is true, did not come up to expectations, as the total was only 428,480 tons, as against 459,585 tons for the preceding week. The trouble was the shortage of prompt tonnage, and the market is still suffering from this. At the end of last week there were thirty-four idle tipping appliances at the various docks in this Channel, and it must be admitted that arrivals of steamers over the week-end were disappointing, as on Monday there were still thirty-five idle appliances, but the following day there was some improvement as the number was reduced to twenty-five, and there were five steamers waiting to berth. It would be very cheering if it could be expected that a further decline in the number of idle tips could be recorded; but, unfortunately, chartering of late has fallen off, and, in fact, last week the total amount of tonnage reported as having been taken up was very little more than half that of the previous week. Tonnage no doubt will be available in larger quantities before long, but what is a satisfactory feature is the fact that merchants appear to have more orders on their hands, and there is keen competition for the tonnage that is offering for employment. Freight rates for practically all directions, except coasting, are firm, and in the case of Upper Mediterranean destinations have advanced much to the disadvantage of those who had earlier concluded c.i.f. business. The inquiry for coals also appears to be slightly better, though it has not yet shown sufficient expansion as to affect coal values beneficially. No specially big inquiry has come on the market, though the intimation has been received that the Egyptian State Railways intend to ask for prices for 60,000 tons of locomotive coals for delivery at Alexandria during December and January next. During the past year these railways have bought from this district 480,000 tons, the current contract for 140,000 metric tons having been placed with Messrs. T. Beynon and Co. at the price of 27s. 1d. per ton c.i.f. Alexandria.

Coal Trade Losses.

The report of the joint accountants of the South Wales Conciliation Board for the three months, May, June and July records a considerable loss in the working of the industry. According to Mr. Finlay Gibson, the Coalowners' secretary, the economic wage certified by the accountants under the procedure laid down in the Conciliation Board Agreement is the lowest under the present agreement. It amounts to 11·08 per cent. below the 1915 standard rates compared with the percentage of 8·4 below these rates certified under the last audit. The miners, however, are guaranteed a minimum percentage of 28 above the 1915 standard rates, and the difference between this and the economic wage of 11·08 per cent. below these rates will have to be found by the colliery owners. The trading loss for the three months amounts to £805,372, or 1s. 6·74d. per ton compared with £693,438, or 1s. 3·99d. per ton in the preceding three months. This is the greatest deficit of the industry in this district under the present general wages agreement, the aggregate deficit now amounting since the first quarter of 1927 to the huge figure of £3,707,665. In the output there was a decrease for the three months as compared with the same period of last year of 823,500 tons, while exports of coal as cargo were down by 660,078 tons. The volume of labour employed in the coalfield in the May–July quarter was the smallest since 1904. The returns of persons engaged give a total of only 163,000, which compared with 197,000 in the early part of 1927.

Pits to Re-open.

After being closed for about five weeks owing to the conditions of employment being too onerous for the owners to operate the property, North's Navigation collieries in the Maesteg area are to re-open for a period. Negotiations took place last week on the basis of an offer put forward by Sir D. R. Llewellyn for the company, and on a Saturday a mass meeting of the miners decided by an overwhelming majority to accept the conditions which it is understood involve a reduction in the minimum from 7s. 4d. to 6s. 10½d. The Maesteg minimum of 7s. 4d. was higher than that in any part of the coalfield, the national minimum being 6s. 10½d. Certain other rules and regulations form part of the terms come to. The suspension of work at these pits affected about 5000 men.

Coal Sales.

Some time ago the Powell Duffryn Steam Coal Company, Ltd., which controls an annual production of about 8,000,000 tons of coal, foreshadowed a change in the marketing of its coals, and at the end of last week the official announcement was made that it had appointed as the sole vendors of the coal and coke produced by the Powell Duffryn and allied companies the firm of Stephenson Clarke and Associated Companies, Ltd. This appointment will not in any way affect the continuity of contracts. This agreement has, of course, meant a number of staff changes, and salesmen who were employed by the Powell Duffryn undertaking have been transferred into the service of Stephenson Clarke and Associated Companies, Ltd., under Mr. Ewart R. Evans, who has been appointed to take charge of the Cardiff office and has been made a local director.

Tin-plate Industry.

Better conditions are looked for from now on in the tin-plate industry of this district as the period of seasonal quietness is drawing to an end. The tone of the market for tin-plates is reported to be steadier, and it shows confidence in the future that work is shortly to be commenced on the erection of a new six-mill tin-plate works at Gurnos near Ystalfera. The report is also current that before long an announcement will be forthcoming of considerable importance to the export side of the industry. It is stated that as the result of negotiations which have been taking place an arrangement has been practically come to between South Wales manufacturers and tin-plate makers in the United States for a division of the world market for tin-plates, thus avoiding competition which in the past has been of the keenest possible character and has meant the reduction in prices in some instances below cost. It is understood that there is to be a further conference at an early date when the scheme will be definitely approved.

Current Business.

Prices all round remain without any material alteration, though there has been a slightly better inquiry. Large coals of most descriptions are still obtainable without difficulty on the basis of the minima figures prevailing, but sized coals and superior smalls are relatively a very steady section. The demand for patent fuel and coke continues to be quiet, while pitwood is below last week's price and is now about 28s. 9d. to 29s.

CATALOGUES.

HERBERT MORRIS, Ltd., Loughborough.—Pamphlet. Morris electric runways.

WAILES DOVE BITUMASTIC, Ltd., Newcastle-on-Tyne.—Copy of the *Bitumastic Bulletin*.

BROOK MOTORS, Ltd., Empress Works, Huddersfield.—Brook bulletin—reduced power costs—longer life.

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—List P240 of cables for pressures from 20,000 to 25,000 volts.

BRADLEY AND CRAVEN, Ltd., Wakefield, England.—Catalogue of colliery haulage and winding engines.

MATHER AND PLATT, Ltd., Park Works, Manchester.—Monograph on Centrifugal Pumps in the Oil Industry.

THE LUNKEN COMPANY, Ltd., 35, Great Dover-street, S.E. 1.—Pamphlet on Stationary and Marine Tachometers.

MAVOR AND COULSON, Ltd., 47, Broad-street, Mile End, Glasgow, S.E.—Folder. A new face-belt conveyor.

PETTERS, Ltd., Westland Works, Yeovil.—A catalogue of heavy oil engines, S.I. type, from 22½ to 90 horse-power.

LAIDLAW, DREW AND CO., Ltd., Edinburgh.—Pamphlet. The oil-firing of Cochran boilers by the Laidlaw-Drew system.

ATELIERS DE CONSTRUCTIONS ELECTRIQUES DE CHARLEROI, 56, Victoria-street, S.W. 1.—Brochure No. 501E on transformers.

RADIO COMMUNICATION COMPANY, Ltd., 34–35, Norfolk-street, Strand, W.C. 2.—List P./628, Marine Radio Equipment.

RANSOME AND MARLES BEARING CO., Ltd., Newark-on-Trent.—Copy of abridged catalogue of British bearings made by the firm.

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—P226. List of cables supplied for working pressures of 11,000 to 13,000 volts.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	18/- to 20/-
(1) Spanish	18/- to 20/-
(1) N. African	18/- to 20/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 14 0	—
No. 1 Foundry	3 15 0 to 3 16 0	—
No. 3 Foundry	3 11 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 8 0	3 8 0
No. 1	3 8 6	3 8 6
Cleveland—		
No. 1	3 8 6	3 8 6
Silicious Iron	3 8 6	3 8 6
No. 3 G.M.B.	3 6 0	3 6 0
No. 4 Foundry	3 5 0	3 5 0
No. 4 Forge	3 4 6	3 4 6
Mottled	3 4 0	3 4 0
White	3 4 0	3 4 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
,, ,, Foundry	3 2 6	—
(3) Northampton—		
Foundry No. 3	2 15 6 to 2 17 6	—
Forge	2 13 6	—
(3) Derbyshire—		
No. 3 Foundry	2 19 6 to 3 0 0	—
Forge	2 16 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 0 0	—
No. 4 Forge	2 18 6	—
Basic	2 19 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 2 0 (a) / 4 4 6 (b) / 4 8 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
LANCS.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	10 10 0	—
Best Bars	11 0 0	—
Hoops	12 10 0	—
MIDLANDS—		
Crown Bars	9 2 6 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 15 0 to 9 0 0	—
Gas Tube Strip	10 15 0 to 10 17 6	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ¼in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 15 0	8 12 6
Sheets (Gal.Cor. 24 B.G.)	13 12 6	13 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	7 12 6	—
Soft Billets	6 15 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	7 10 0 to 10 0 0	—
MANCHESTER—		
Bars (Round)	8 17 6	—
,, (Small Round)	7 15 0	—
Hoops (Baling)	10 0 0	9 15 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6 to 8 17 6	—
,, (Lancs. Boiler)	9 12 6 to 9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Hard Basic	7 2 6 and 7 12 6	—
Intermediate Basic	7 0 0	—
Soft Basic	6 5 0 to 6 7 6	—
Hoops	9 0 0	—
Soft Wire Rods	7 5 0 to 7 10 0	—
MIDLANDS—		
Small Rolled Bars	7 7 6 to 8 0 0	—
Billets and Sheet Bars	6 2 6	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 7 6 to 13 12 6	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	11 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/- to 18/3
Block Tin (cash)	213 10 0
,, (three months)	210 0 0
Copper (cash)	62 16 3
,, (three months)	63 6 3
Spanish Lead (cash)	22 7 6
,, (three months)	22 1 3
Spelter (cash)	24 16 3
,, (three months)	24 17 6
MANCHESTER—	
Copper, Best Selected Ingots	67 0 0
,, Electrolytic	69 10 0
,, Strong Sheets	94 0 0
,, Tubes (Basis Price), lb.	0 1 1½
Brass Tubes (Basis Price), lb.	0 1 0
,, Condenser, lb.	0 1 2
Lead, English	23 17 6
,, Foreign	22 10 0
Spelter	25 2 6
Aluminium (per ton)	£107

FERRO ALLOYS.

Tungsten Metal Powder	1/7 per lb.	
Ferro Tungsten	1/3 per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 10 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£20 10 0	7/-
,, ,, 8 p.c. to 10 p.c. ,,	£20 0 0	6/-
,, ,, Specially refined		
,, ,, Max. 2 p.c. carbon	£33 0 0	12/-
,, ,, ,, 1 p.c. carbon	£37 0 0	15/-
,, ,, ,, 0·70 p.c. carbon	£42 0 0	17/-
,, ,, ,, carbon free	1/- per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home	
	£13 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£19 0 0 scale 6/- per unit	
,, Vanadium	14/- per lb.	
,, Molybdenum	4/3 per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/- per lb.	

FUELS.

SCOTLAND.
(*Prices not stable.*)

	Export
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/9
,, ,, Ell	14/3 to 14/6
,, ,, Splint	16/- to 17/-
,, ,, Trebles	13/3
,, ,, Doubles	13/-
,, ,, Singles	12/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/6
,, ,, Jewel	15/6
,, ,, Trebles	13/6 to 13/9
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	11/- to 12/6
Screened Navigation	18/-
Trebles	14/- to 14/6
Doubles	13/6 to 13/9
Singles	12/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/3
Secondary Steam	11/9
Trebles	13/6
Doubles	13/3
Singles	12/6

ENGLAND.

(8) N.W. COAST—	
Steams	24/- to 25/-
Household	37/6 to 50/-
Coke	22/6 to 23/6
NORTHUMBERLAND—	
Best Steams	13/3 to 13/6
Second Steams	11/9 to 12/-
Steam Smalls	9/- to 9/6
Unscreened	11/9 to 12/-
Household	21/- to 27/-
DURHAM—	
Best Gas	15/-
Second	13/3 to 13/9
Household	21/- to 27/-
Foundry Coke	18/3 to 19/-

SHEFFIELD—	Inland.
Best Hand-picked Branch	26/- to 27/6 —
Derbyshire Best Bright House	21/6 to 22/6 —
Best House Coal	19/6 to 20/6 —
Screened House Coal	16/- to 17/- —
,, ,, Nuts	14/6 to 16/- —
Yorkshire Hards	14/6 to 16/- —
Derbyshire Hards	14/6 to 16/- —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	4/6 to 6/- —
Smalls	3/- to 4/6 —
Blast-furnace Coke (Inland)	13/- at ovens —
Furnace and Foundry Coke (Export), f.o.b.	19/- to 19/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	19/3 to 19/6
Second Smokeless Large	18/- to 19/-
Best Dry Large	17/9 to 18/6
Ordinary Dry Large	17/- to 17/3
Best Black Vein Large	17/6 to 17/9
Western Valley Large	17/- to 17/3
Best Eastern Valley Large	16/6 to 17/-
Ordinary Eastern Valley Large	16/3 to 16/6
Best Steam Smalls	12/6 to 13/-
Ordinary Smalls	10/6 to 12/-
Washed Nuts	16/6 to 19/-
No. 3 Rhondda Large	19/6 to 20/-
,, ,, Smalls	14/- to 14/6
No. 2 ,, Large	16/- to 16/6
,, ,, Through	14/6 to 15/6
,, ,, Smalls	12/6 to 13/6
Foundry Coke (export)	27/- to 36/-
Furnace Coke (export)	19/- to 21/-
Patent Fuel	20/6 to 21/6
Pitwood (ex ship)	28/9 to 29/-
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	34/- to 35/6
Seconds	24/6 to 27/6
Red Vein	20/6 to 27/-
Machine-made Cobbles	40/- to 43/6
Nuts	35/- to 43/6
Beans	23/6 to 26/-
Peas	18/- to 19/-
Breaker Duff	8/- to 8/3
Rubbly Culm	11/9 to 12/3
Steam Coals :	
Large	17/6 to 18/6
Seconds	16/- to 17/-
Smalls	10/- to 12/6
Cargo Through	15/- to 16/-

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(*From our own Correspondent in Paris.*)

European Coal Pact.

A QUESTION that is being seriously discussed at the moment is the desirability of negotiating for a pact amongst all the European coalowners. If the present deplorable state of the coal industry were due to temporary causes, there would be no reason for alarm, since a general industrial activity would be sufficient to bring back some prosperity to the coal trade. But the future appears to be far from encouraging in view of the fact that the miners' strike in Great Britain was followed by an immediate and permanent increase in the continental coal production. Furthermore, owing to organised efforts to economise coal and provide substitutes, there has been no increase in the coal consumption equivalent to the greater output. There is no doubt that the colliery industry will be saved eventually by the chemical treatment of coal at the collieries themselves; but meanwhile, in the opinion of the colliery companies on the Continent, it is evident that if trouble is to be avoided the production of coal must be brought within the limits of consumption; otherwise, there will be a further closing of pits without benefiting those that continue to produce. This is what is now taking place practically everywhere. There has been a reduction in the number of miners at work in the Saar, and more especially in the Ruhr, and lately conferences have been held between the men and coalowners' representatives in the Nord, Anzin, and Pas de Calais fields, when the latter refused to accede to the demand for an increase of wages. They averred that any advance would mean an immediate closing of pits. There is undoubtedly a disturbing feeling in the French coal trade, for the men insist that they must be paid on the basis of the higher cost of living; but they hesitate to take action because they are fully alive to the possible serious consequences. The only encouraging element at the moment is the rather better situation of coalowners in Belgium, and, to a less extent, in Germany, through a more active demand for industrial coal, but this does not change the outlook which is overshadowed by an unwieldy surplus production of coal. German, Belgian, French, and Polish coalowners would gladly enter upon the proposed pact, but nothing can be done unless Great Britain becomes a party to it, and although it is understood that British coalowners have been approached with the object of soliciting their support, it is recognised by continental coalowners that it is hopeless to attempt to negotiate in the absence of an organisation of the British coal-mining industry. Moreover, the negotiations would certainly encounter serious difficulties, since the object of the proposed pact is to secure for each country its own market and to allot territories, while a central sales office will be instituted for foreign markets. Almost certainly, also, British coal producers would be asked to forego their monopoly of coal supply to the Dominions. In a word, the proposed pact would reduce seriously the British participation in the world's trade, although the sales of coal abroad would be effected at a profit.

The Tube Union.

The negotiations which are being carried out with German tube firms by the P.L.M. railway company on behalf of all the French railways for the supply of tubes on account of reparations for the equipment of Westinghouse brakes on goods trains show that the situation of the International Tube Union is not so unassailable as is usually believed. The value of the contract is 50 million marks. The inquiry was first made through the International Tube Union, and the price was fixed when an offer was made by the Benteler Maschinenfabrik, of Bielefeld, to supply the tubes at a reduction of 30 per cent. upon the official price. The order was therefore given to the Benteler concern, and since then there has been considerable trouble with the members of the German Tube Union and their suppliers, who refuse to provide the outside firm with facilities to execute the contract. They assert that the Benteler concern will be unable to supply tubes to the Union's specification. On the other hand, it is affirmed that the Benteler Maschinenfabrik has been able to obtain assistance whereby it will be in a position to manufacture the tubes to the required specification, and, if that be the case, it is clear that the situation of the Tube Union will be seriously weakened.

Seaplane Catapult.

The successful launching of a seaplane from the Transatlantic liner "Ile de France" has drawn attention to the catapult employed, which was designed and constructed by the Chantiers de Penhoët. There is nothing special in the general lines of the catapult, but its details had to be worked out with quite exceptional prevision for a mechanical contrivance of that size, and so rapid are the movements that the proper working of details could only be ascertained by slow kinematograph films. The seaplane is held by hooks on a carriage running on rails rather less than 30 m. long. The carriage has to be propelled with almost absolute uniform acceleration over that distance at a speed of more than 60 miles an hour. The movement is given to the carriage by a compressed air cylinder and piston through the medium of a 2in. steel cable passing over a seven-sheave block to multiply the travel. A special form of valve admits the air instantaneously at very high pressure at the moment the carriage is released, and the volume of air is increased by a second valve to insure a constant pressure during the second of time the carriage is travelling over the rails. This almost absolutely constant acceleration is regarded as essential to the satisfactory working of the device. As soon as the carriage reaches the end of the rails the seaplane is released. The carriage weighs a ton, and, travelling at more than 60 miles an hour, it has to be brought to a standstill within a distance of 2 m. The brake is composed of a number of compressed air cylinders carrying pistons with jaws which receive steel projections from the carriage. The energy required to launch the machine during about one second of time is 3000 horse-power. It is stated that the difference between the ideal acceleration and that actually obtained does not exceed 1 per cent. Every possible safety device has been adopted to avoid risk of accident. The practical results obtained both at New York and Cherbourg were perfectly satisfactory.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

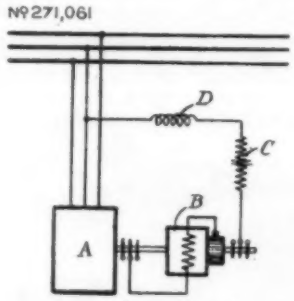
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

271,061. April 27th, 1927.—IMPROVEMENTS IN OR RELATING TO ELECTRIC SYSTEMS COMPRISING AN ASYNCHRONOUS MACHINE CASCADED WITH A COMMUTATOR MACHINE, Siemens-Schuckertwerke Gesellschaft mit beschränkter Haftung, of Berlin-Siemensstadt, Germany.

The drawing shows an asynchronous machine A, which may be a motor or a generator, and which at the same time also has to supply wattless current. B is a cascade commutator machine. Its rotor is excited with current at the network frequency, for the supply of the magnetising current. C is the excitation transformer for the commutator machine. At the normal network voltage, the iron of the excitation transformer is well saturated. Moreover, the leakage of dispersion in the excitation circuit is increased by connecting choking coils D in series with the transformer C. Owing to the iron saturation of the transformer C, the latter takes up a large magnetising

№ 271,061

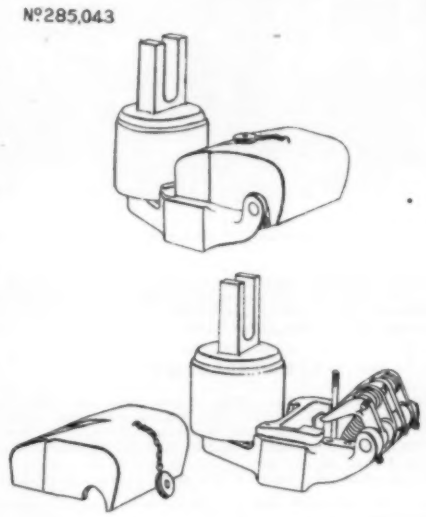


current which passes through the choking coils D, which latter reduce the resulting excitation voltage to a considerable extent. If the voltage in the network drops, the excitation current of the commutator machine B, and therefore the excitation of the main machine, will not at first decrease to a large extent, as the magnetising current in the transformer C will strongly decrease owing to the disappearance of the iron saturation, and therefore the action of the choking coils D will also decrease. In the case of variations of the wattless current supply, the voltage in the network will fluctuate to a considerably smaller extent than usual. The danger of a collapse of the voltage on account of inductive load shocks is also considerably reduced. The arrangement will, however, also act in a favourable manner in the case of changes in the effective energy, as the fall of voltage caused by the leakage or dispersion of the main machine will no longer weaken the excitation of the commutator machine.—*July 27th*, 1928.

285,043. February 9th, 1928.—IMPROVEMENTS IN OR RELATING TO BRUSH HOLDERS FOR DYNAMO ELECTRIC MACHINES, *International General Electric Company, Incorporated, of* 120, *Broadway, New York.*

The invention relates to brush holders for the driving motors of electrically-propelled vehicles, particularly railway vehicles. In ventilated motors of this kind, the passage of dust with the cooling air through the interior of the motor must be reckoned with. The brush holders are generally placed at an angle of

№ 285,043



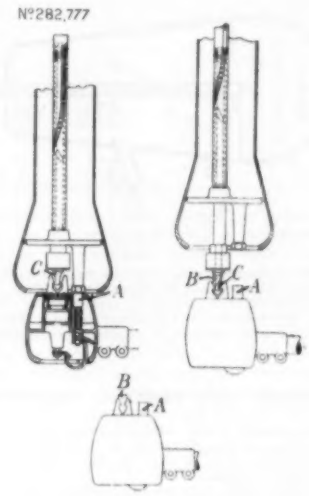
45 deg. in the upper part of the casing, and there is the possibility of dust being deposited in the brush holder chambers and pockets. Flashing over then easily occurs when the short-circuit brake is applied abruptly, and this causes damage to the pressure fingers and springs. In accordance with this invention a cap of sheet metal or insulating material is placed over the sliding carbons and the pressure fingers. The cap not only prevents the trouble mentioned, but if it is made of insulating material it also avoids damage by sparking.—*August 2nd*, 1928.

SWITCHGEAR.

282,777. December 23rd, 1927.—IMPROVEMENTS IN OR RELATING TO OIL IMMERSED ELECTRICAL CIRCUIT INTERRUPTERS, *Metropolitan-Vickers Electrical Company, Ltd., of* 4, *Central-buildings, Westminster.*

This specification describes an oil immersed circuit interrupter having relatively movable main and auxiliary contacts A and B, one of the auxiliary contacts being carried by the moving portion and the other being slidably mounted on the stationary portion of the circuit interrupter. When the circuit interrupter is closed and during the operation of circuit interruption these two contacts are held together by a latching device C, until the main contacts have separated. One part of the latching device is carried by a rod which is slidably and rotatably mounted in the stationary member of the circuit interrupter, the rod being pro-

№ 282,777

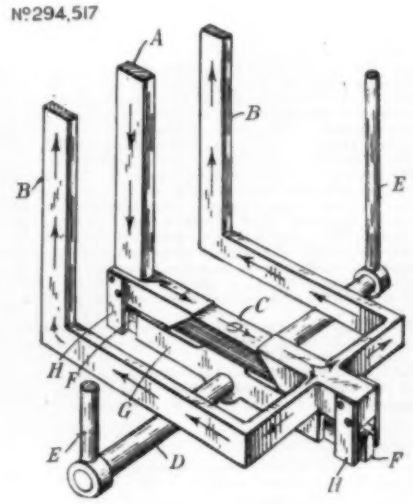


vided with a pin which, during the sliding movement of the rod, moves in a slot, the end part of which is spirally formed so that the rod towards the end of its sliding movement is caused to rotate on its axis and release the latching device. With the improved arcing contact members, a very heavy current can be interrupted without danger of pitting the main contact member, and at the same time the final separation of the auxiliary contact members is effected within a relatively few cycles of an alternating current.—*August 2nd*, 1928.

294,517. April 25th, 1927.—IMPROVEMENTS IN OR RELATING TO ELECTRIC CIRCUIT-BREAKERS OR SWITCHES, A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, Durham, and Frank Coates, of Cranlea, Whitburn-road, Cleadon, Durham.

This invention relates to electric circuit-breakers or switches suitable for carrying heavy currents. In such circuit-breakers comparatively large electro-magnetic forces are often set up by the currents flowing in the conductors leading to and from the fixed contacts and the movable contact member, and these forces are likely to tend to open the switch or retard its closing. The object of the invention is to provide an arrangement of the conductors and contacts of a simple and robust nature in which the forces referred to are minimised. A central or leading conductor A is equally spaced from and parallel to two

№ 294,517



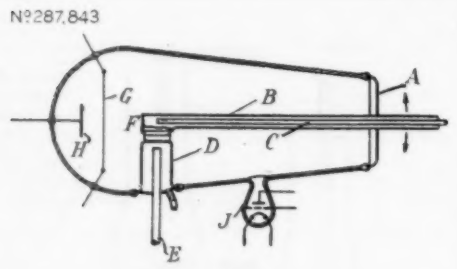
outer or return conductors B, each being formed with a right angled bend so that their lower portions are horizontal. The horizontal portion of the conductor A contains a gap which is closed by a brush contact member C supported beneath the gap by an insulated bar D which is movable up and down by means of the plunger rods E in order to close and open the switch. When the switch is closed the current flows down the conductor A, through the fixed and movable contacts, along the horizontal portions of the conductors B, thence returning up their vertical portions as indicated by the arrows. Sparking contacts F are carried on the cross member G and co-operate with fixed contacts H. The electro-magnetic forces due to the currents in the outer conductors are opposed to those in the central conductors, and thus any forces tending to open the movable contacts are neutralised or reduced.—*July 25th*, 1928.

287,843. February 7th, 1928.—IMPROVEMENTS IN OR RELATING TO HIGH-VACUUM SWITCHES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany. Assignees of Siemens-Schuckertwerke Gesellschaft mit beschränkter Haftung, of Berlin-Siemensstadt, Germany.

A glass container is closed off by means of the copper cap A at one end. The electrode holder B is in the form of a tube, and is provided inside with a tube C, through which some kind of cooling medium may be conducted. The counter contact is fastened to the metal tube D, to which a cooling medium can be supplied through the tube E. The contacts proper consist of tantalum discs attached to the electrode holders B and D respectively. In order that, before placing the switch in operation, the electrodes and their conductors or supply wires may be well degasified, an incandescent cathode G is provided. When this cathode is heated and a high tension is established between the incandescent cathode and the electrodes and their feed connections, these parts can be heated by an electron bombardment and be well degasified. In order to bind any residual gas the electrode H, coated with magnesium or alkaline earth

metal can be heated by the electron bombardment. Instead of this electrode, heated wires may be used. To enable the vacuum to be controlled at any time the high vacuum vessel is connected to a vessel or container J which is provided with an incandescent cathode and two electrodes, such as are normally used for example in the ordinary amplifier tubes. By measuring

N°287,843



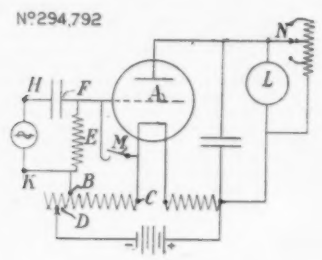
the ion current between the electrodes contained in the vessel J the vacuum can at once be determined. The opening and closing of the contact is caused by movement of the electrode holder B in the direction of the arrow shown. The movement can be effected with the aid of a system of magnets.—*August 2nd*, 1928.

MEASURING AND TESTING INSTRUMENTS.

294,792. September 17th, 1927.—IMPROVEMENTS IN INSTRUMENTS FOR THE MEASUREMENT OF ALTERNATING POTENTIAL DIFFERENCES, Eric Balliol Moullin, of, 13, Brookside, Cambridge, England.

This invention relates to improvements in measuring instruments for the measurement of alternating electromotive forces of any frequency and particularly values up to about 100 volts. The grid A of a thermionic valve is connected to a point B on the resistance C D, through a resistance E. A condenser is provided at F. The terminals of the instrument are marked H and K. When an alternating potential difference is applied to these terminals the asymmetric conductivity between the grid and filament of the valve allows a small unidirectional current to flow through the resistance E and thereby causes the grid to attain a potential whose mean value is negative to the point B. But the mean potential of the grid is less than the peak

N°294,792

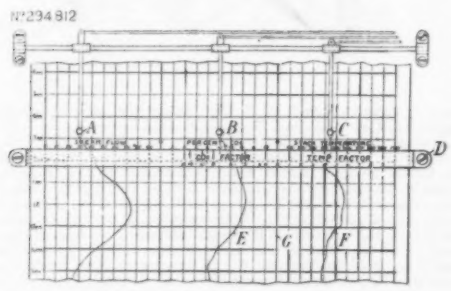


value of the alternating P D between the terminals K and H, and consequently the grid becomes positive to the point B during a portion of each positive half-cycle of alternating potential between H and K. During the periods when the grid is thus made positive to the point B the anode current will be enhanced and the net result of applying an alternating potential difference between H and K is an increase in the mean value of the anode current flowing through the galvanometer L. The scale of the galvanometer is calibrated so as to read directly the virtual value of the alternating voltage applied between H and K and the whole combination of galvanometer, battery, condensers and resistances forms a direct-reading portable alternating-current voltmeter. The purpose of the switch M is to allow the galvanometer to be used as an indirect measure of the filament current and the potential of the grid and anode. The shunt switch N alters the range of the instrument.—*August 2nd*, 1928.

294,812. November 4th, 1927.—MEANS FOR MEASURING FURNACE EFFICIENCY, *Electroflo Meters, Ltd., Abbey-road, Park Royal, London, N.W. 10.*

The object of this instrument is to enable a boiler to be worked at the best efficiency regardless of the load it has to carry. It is based on the equation L = K W T, where L is the percentage

N°294,812



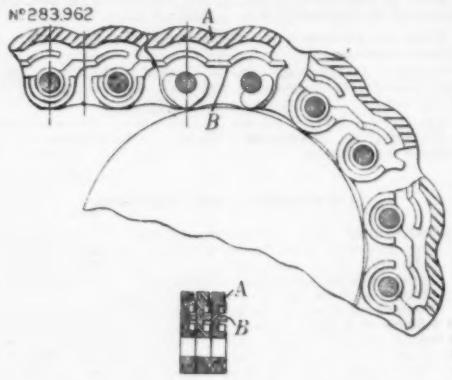
efficiency, K is a constant determined by experiment on the boiler, W is the weight of the gases going up the chimney, and T is their temperature. W is determined by the percentage of CO_2 in the gases. Three styluses A, B and C are connected with instruments for determining the rate of steam flow, the percentage of CO_2 and the stack temperature. They draw graphs on a chart moved by clockwork and ruled with ordinates appropriately. On the transparent bridge D there are graduations which enable the distance of the two graphs E and F from the datum line G to be measured. A simple calculation with these readings gives the efficiency of the boiler.—*August 2nd*, 1928.

FURNACES.

283,962. September 9th, 1927.—CHAIN-GRATE STOKERS, A. W. Bennis and Co., Ltd., Little Hulton, Bolton.

This grate is intended for burning very fine fuel, such as coke breeze. It is built up of links which are slightly narrower at the top working face than at the bosses where they are pinned together. Towards the upper face small diagonal grooves A are formed to direct the draught of air towards the front of the furnace. The opposite side of each link is plain. There are also fins B on the sides of the links which form pockets for the reception of riddlings from the fire. As the chain passes over the

N°283,962



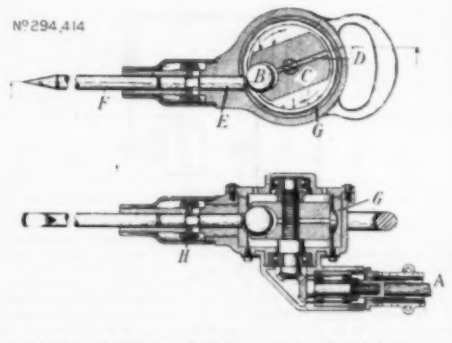
tumbler at the rear of the stoker the contents of these pockets are tipped into the ashpan.—*August 2nd*, 1928.

MACHINE TOOLS AND SHOP APPLIANCES.

294,414. August 27th, 1928.—PERCUSSION HAMMERS, G. H. Thompson, 947, Bristol-road South, Selly Oak, Birmingham.

This is a mechanical percussive hammer, driven by the flexible shaft A. It depends for its action on the centrifugal force of the ball B housed loosely in the rotor C. The hole D through the

N°294,414

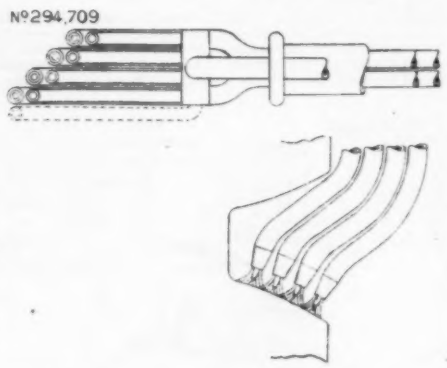


rotor admits air behind the ball so as to leave it quite free. The hammer plunger E for the tool F receives a blow from the ball at each revolution. During the remainder of the revolution the ball runs in the hardened race G. The adjustable stop H determines the projection of the hammer plunger into the ball race.—*July 26th*, 1928.

294,709. May 3rd, 1927.—SURFACE HARDENING OF STEEL, G. H. Fletcher, 22, Glentilt-road, Eccleshall, Sheffield; C. L. Sumpter, Tithebarn, Baslow; and Metropolitan-Vickers Electrical Company, Ltd., 4, Central-buildings, Westminster.

This torch is intended for the surface hardening of steel

N°294,709



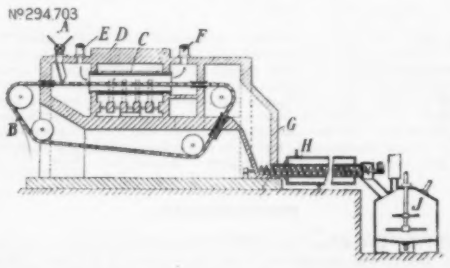
objects, such as gear wheel teeth. It is provided with a number of jets, as shown, which conform to the surface to be hardened and immediately in the rear of each heating jet there is another jet for cooling water.—*August 2nd*, 1928.

METALLURGY.

294,703. February 6th, 1928.—EXTRACTION OF TIN FROM SLIME TIN, F. L. Wilder, 150, Southampton-row, London, W.C. 1; E. Morris, 150, Southampton-row; E. Schiff, 150, Southampton-row; and E. S. King, 34, Dover-street, London, W. 1.

The tin-containing material in a state of fine subdivision is

N°294,703



fed from a gas-tight hopper A on to a conveyor B which passes through an externally heated cast iron muffle C in the furnace D. The temperature is from 200 deg. to 300 deg. Cent. Sulphur vapour is slowly blown in at E and escapes at F. The resulting material is discharged by the conveyor into the cooling chamber G and is reduced to a temperature of 90 deg. in the jacket H. It is finally treated with an ammonium polysulphide solution in the leacher J and metallic tin is recovered by electrolysis. The vapour escaping at F is condensed with ammonium carbonate and the resulting sludge is added to the charge of the leacher. In the electrolytic cell a current density of about 1 ampère per square decimetre and a pressure of 0·3 volt are used. The efficiency is then said to be 95 per cent.—*August 2nd*, 1928.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

THE INSTITUTE OF METALS.—Annual autumn meetings at Liverpool. For programme see page 129, August 3rd.

WEDNESDAY, SEPTEMBER 5TH, TO SATURDAY, SEPTEMBER 22ND.

THE FOURTH MACHINE TOOL AND ENGINEERING EXHIBITION, at Olympia.

THURSDAY AND FRIDAY, SEPTEMBER 6TH AND 7TH.

NORTH BRITISH ASSOCIATION OF GAS MANAGERS.—Annual general meeting in the Masonic Hall, George-street, Edinburgh. 10 a.m., discussion upon Mr. R. M. Simpson's paper, "Lands Valuation and Income Tax Charges;" William Young Memorial Lecture, by Dr. Charles Carpenter, C.B.E., London. 2.30 p.m., paper by Mr. George Braidwood, Coatbridge, "Quality." The Lord Provost, Magistrates, and Councillors of the City of Edinburgh invite the members and friends to a reception in the City Chambers, on Thursday, September 6th, at 8 p.m. An excursion on September 7th will be by train to Melrose, leaving Edinburgh (Waverley Station) at 10.10 a.m.

SATURDAY, SEPTEMBER 8TH.

BELFAST ASSOCIATION OF ENGINEERS.—Visit to Dundalk to inspect the locomotive works of the Great Northern Railway Company. Leave Belfast at 2.30 p.m.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Great Yarmouth. Eastern District meeting. 11 a.m

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Morpeth. North-Eastern District. 2 p.m.

THURSDAY AND FRIDAY, SEPTEMBER 13TH AND 14TH.

THE CERAMIC SOCIETY: REFRACTORY MATERIALS SECTION.—The Societies' Room in the Royal Technical College, George-street, Glasgow. Papers: "Refractories for Electric Elements," by Mr. P. Cooper; "Notes on Refractories for Salt Glazed Kilns," by Mr. W. Emery; "Drying Cracks," by Mr. C. E. Moore; "The Functions of Regenerators in Relation to the Properties of the Refractories of Construction," by Mr. A. T. Green; "A Comparison of the Properties and Industrial Durability of Lime-bonded and Clay-bonded Silica Bricks," by Mr. W. J. Rees; and "The Dissociation of Carbon Monoxide in Contact with Fire-clays and Silica," by Messrs. W. J. Rees and D. W. Hubbard. At 10.30 a.m. each day.

FRIDAY, SEPTEMBER 14TH, TO SUNDAY, SEPTEMBER 16TH.

THE ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX.—Fifth annual Conference at New College, Oxford.

SATURDAY, SEPTEMBER 15TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Visit to the locomotive works of the Vulcan Foundry, Ltd., Newton-le-Willows. Train leaves Exchange Station, Manchester, at 8.55 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Swanage. South-Western District meeting. 11.30 a.m.

TUESDAY AND WEDNESDAY, SEPTEMBER 25TH AND 26TH.

IRON AND STEEL INSTITUTE—Autumn meeting in Bilbao, Spain. For programme see page 209, August 24th. 10 a.m. each morning.

FRIDAY AND SATURDAY, SEPTEMBER 28TH AND 29TH.

THE FARADAY SOCIETY.—A general discussion on "Homogeneous Catalysis," to be held in the Physical Chemistry Laboratory of the University of Cambridge.

SATURDAY, OCTOBER 6TH.

ELECTRICAL POWER ENGINEERS' ASSOCIATION: SOUTHERN DIVISION.—Hotel Cecil, Strand, W.C. 2. The tenth annual dinner to the members of the National Executive Council, at 5.30 for 6 p.m. Tickets, 7s. 6d., may be obtained from P. Gordon Hieatt, hon. secretary, Southern Division, 25, Parkhurst-road, Bowes Park, N. 22.

EDUCATION FOR "MANAGEMENT."—The Polytechnic, Regent-street, London, W., has in an experimental way provided, for four years past, courses of instruction with the aim of making more effective contact between education and industry in order that the fullest value may be obtained from the educational resources of the country in the development of national industry and commerce. For the coming session arrangements are being made with the Institute of Industrial Administration to hold examinations under the joint control of the Institute and The Polytechnic. The course is designed to help those men and women who, having the personal qualities of leadership, require, in addition, a sufficient training in the technique of industrial administration to undertake the management of business organisations which every day increase in size and complexity. For the session beginning this month the course will include such subjects as economics, industrial history, industrial psychology, *personnel* administration and welfare, costing, management, and statistics. Those who are interested can obtain details from the director of education of The Polytechnic.